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This report presents the results of the U.S. Environmental Protection Agency's 1985 National Audit Program by pollutant and by analytical method. Semiannual audits were conducted for Pb, NO_3 and SO_4 (filter strips) and acid rain, and annual audits were conducted for SO_2 (bubbler), NO_2 (bubbler), CO and high volume flow rate. Continuous SO_2 monitors were audited throughout the year, such that no monitor was audited more than once. Approximately 30 laboratories participated in each semiannual acid rain audit. Twelve laboratories participated in the SO_2 bubbler audit, and 18 in the NO_2. Approximately 55 laboratories participated in each NO_3 and SO_4 audit and approximately 100 laboratories in each Pb audit. Three hundred and twenty-five CO monitors, 257 SO_2 monitors and 1336 high volume flow samplers were also audited. The results for each 1985 audit are presented in tabular form for each concentration level. The overall performance for all participants for each audit conducted since the beginning of the program is also illustrated in a series of figures.

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-1985-

by

Blaine F. Parr, Robert L. Lampe, Gregory Pratt,
Oscar L. Dowler and William J. Mitchell
Quality Assurance Division
Environmental Monitoring Systems Laboratory
Research Triangle Park, North Carolina 27711

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

This report presents the results of the U.S. Environmental Protection Agency's 1984 National Ambient Air Performance Audit Program by pollutant and by analytical method. Semiannual audits were conduced for Pb, NO_3^- and $SO_4^=$ on filter strips and acid rain. Annual audits were conducted for SO_2 (bubbler), NO_2 (bubbler), CO and high-volume sampler flow rate. Continuous SO_2 monitors were audited throughout the year, with no monitor being audited more than once. Approximately 33 laboratories participated in each semi-annual acid rain audit. Twelve laboratories participated in the SO_2 bubbler audit, and 18 in the NO_2 audit. Approximately 54 laboratories participated in each NO_3^- and $SO_4^=$ audit and approximately 105 laboratories in each Pb audit. Three hundred and twenty-five CO monitors, 257 SO_2 monitors and 1336 high volume flow samplers were also audited. The results for each audit are presented in tabular form for each concentration level. The overall performance for all participants for each audit conducted since the beginning of the program is also illustrated in a series of figures. For the most part the results of the 1985 audits are essentially unchanged from the 1983 and 1984 audits.

CONTENTS

	Page
Abstract	iii
Tables	v
Figures	vii
Acknowledgments	viii
1. Introduction	1
2. Summary and Conclusions	3
3. Audit Materials	4
4. Audit Results	7
References	12
Tables	13
Figures	39

TABLES

Number		Page
1	Agency Participation	13
2	Audit Results for Manual Sulfur Dioxide	14
3	Results for the Pararosaniline Method	15
4	Percent of Sulfur Dioxide Measurements Within Indicated Percent of Assigned Values (Statistical Outliers Removed)	16
5	Audit Results for Nitrogen Dioxide	16
6	Audit Results for Nitrogen Dioxide by the Sodium Arsenite Method	17
7	Percent of Nitrogen Dioxide Measurements Within Indicated Percentage of Assigned Value (Statistical Outliers Removed)	18
8	Audit Results for Carbon Monoxide	18
9	Audit Results for Carbon Monoxide by the NDIR Method	19
10	Percent of Carbon Monoxide Measurements Within Indicated Percentage of Assigned Value	19
11	Audit Results for Sulfate on Filter Strips	20
12	Audit Results for Sulfate by the Manual Methods	21
13	Audit Results for Sulfate by the Automated Methods	22
14	Percent of Sulfate Measurements Within Indicated Percentage of Assigned Value	23
15	Audit Results for Nitrate on Filter Strips	24
16	Audit Results for Nitrate by the Automated Methods	25
17	Percent of Nitrate Measurements Within Indicated Percentage of Assigned Value	26
18	Audit Results for Lead on Filter Strips	27
19	Percent of Lead Measurements Within Indicated Percentage of Assigned Value	28
20	Audit Results for Sulfur Dioxide Continuous Monitors (All Data)	29
21	Audit Results for Sulfur Dioxide Continuous Monitors by Various Instrumental Methods	29
22	Percent of Hi-Vol Flow Measurements Within Indicated Percentage of Assigned Value (All Data)	30
23	Acid Rain Results for pH, Conductivity and Acidity (All Data)	31

TABLES (Con't.)

Number		Page
24	Acid Rain Audit Results for pH, Conductivity and Acidity (Outliers Removed)	32
25	Acid Rain Audit Results for Anions (All Data)	33
26	Acid Rain Audit Results for Anions (Outliers Removed). . .	34
27	Acid Rain Audit Results for Cations (All Data)	35
28	Acid Rain Audit Results for Cations (Outliers Removed) . .	36
29	Acid Rain Audit Results for Trace Metals (All Data). . . .	37
30	Acid Rain Audit Results for Trace Metals (Outliers Removed)	38

FIGURES

Number		Page
1	SO_2 Bubbler Audits	39
2	NO_2 Bubbler Audits	39
3	Carbon Monoxide Audits	40
4	Sulfate Audits	40
5	Nitrate Audits	41
6	Lead Audits	41
7	Acid Rain Audit Results for pH	42
8	Acid Rain Audit Results for Conductivity	42
9	Acid Rain Audit Results for Acidity	43
10	Acid Rain Audit Results for SO_4 (Reported as S)	43
11	Acid Rain Audit Results for NO_3 (Reported as N)	44
12	Acid Rain Audit Results for Cl	44
13	Acid Rain Audit Results for F	45
14	Acid Rain Audit Results for NH_4 (Reported as N)	45
15	Acid Rain Audit Results for Ca	46
16	Acid Rain Audit Results for K	46
17	Acid Rain Audit Results for Mg	47
18	Acid Rain Audit Results for Na	47
19	Acid Rain Audit Results for Mn	48
20	Acid Rain Audit Results for Fe	48
21	Acid Rain Audit Results for Cd	49
22	Acid Rain Audit Results for Ca	49
23	Acid Rain Audit Results for Ni	50
24	Acid Rain Audit Results for Pb	50
25	Acid Rain Audit Results for Zn	51

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SECTION 1

INTRODUCTION

The ambient air audits of analytical proficiency are managed by the Environmental Monitoring Systems Laboratory (EMSL), of the U.S. Environmental Protection Agency (EPA). These audits are a part of a continuing program entitled the National Performance Audit Program. This program allows EPA to monitor the performance of laboratories (agencies) making air pollution measurements to assist EPA in assessing the quality of air monitoring data. It also allows participating agencies to assess their performance with respect to other agencies making similar measurements. The audits are conducted by the Quality Assurance Division (QAD) of EMSL. Inquiries and applications to participate should be directed to: U.S. Environmental Protection Agency, Quality Assurance Division, Environmental Monitoring Systems Laboratory, MD-77B, Research Triangle Park, North Carolina 27711.

Agencies participating in the audits are mostly solicited by the EPA Regional Quality Control Coordinator in each of EPA's 10 regions. Agencies performing ambient air monitoring of criteria pollutants are required by Federal regulation to participate. Once a laboratory enrolls in a particular audit, it is assigned a permanent identifying code number and automatically notified of subsequent audits. Federal, state, local, industrial and foreign air pollution monitoring agencies participate in the surveys.

Sample materials furnished for the audits simulate the several types of collected air pollution samples as closely as possible. The materials for the manual methods evaluate only the analytical portion of the total air measurement process; i.e., they do not determine errors in sample collection, transportation, handling, storage, and data processing. For the high volume method for total suspended particulate (TSP), the audit evaluates only the flow measurement portion of the method. Throughout this report, reference is made to "assigned values." These values are the standards against which reported results are evaluated and have been so designated after consideration of the analytical results of the referee laboratory, the QAD/EMSL Standards Laboratory, and the manufacturer of the audit material.

In 1985, audits were conducted twice for lead, sulfate, nitrate and acid rain and once for carbon monoxide, high-volume flow rate, and the manual sulfur dioxide and nitrogen dioxide (bubbler) methods. Audits on sulfur dioxide continuous monitors were conducted throughout the year.

Each laboratory participating in an audit received an evaluation of its performance shortly after the audit was completed. When practical,

laboratories submitting abnormally high or low results were offered an opportunity to analyze another set of samples. However, the retest results are not included in this summary report. In any case, laboratories having excessively deviant values should have investigated their operations to identify and correct the cause of the large errors.

Approximately 680 laboratories are registered in the National Ambient Air Performance Audit Program. This report presents the results of approximately 425 laboratories that participated in the 1985 audits. The category and number of participants in each audit are presented in Table 1. Compared to the 1984 audits participation decreased in the following audits (percentage decline in parentheses): SO_2 bubbler (40%), NO_2 bubbler (15%), CO (1.5%), high volume flow rate (5%) and acid rain (6%). A 2% increase occurred in the Pb and $SO_4^=$ on filter strip audits, but the NO_3^- on filter strip audit was unchanged. A 16% increase occurred in the SO_2 continuous monitor audit. These changes continue trends found in the earlier audits (2, 3).

SECTION 2

SUMMARY AND CONCLUSIONS

The 1985 results closely parallel those of the last two years (1, 2). With outliers removed and the values for all levels averaged, the percentage of results within 20 percent of the assigned values ranged from a low of 90% (flow rate) to a high of 100% (NO_2 and SO_2 bubbler methods). The following percentage of results were rejected as outliers for each type of audit: SO_2 bubbler (5%), NO_2 bubbler (5.7%), CO (4.5%), $SO_4^=$ (4.4%), NO_3^- (8.3%), Pb (5.27%), flow rate (3.8%), SO_2 continuous (1.0%) and acid rain (approximately 3%).

SECTION 3

AUDIT MATERIALS

The audit samples span the wide range of pollutant concentrations experienced in ambient air monitoring. This is achieved directly with the CO samples, which are prepared in cylinders. Dilution is necessary for the acid rain samples, lyophilized SO_2 and aqueous NO_2 samples in order to obtain desired concentrations. Lead, NO_3^-, and $SO_4^=$ filter strip samples require both dissolution and dilution to arrive at the needed range of concentrations. The SO_2 continuous monitor audit samples require dilution of the SO_2 with zero air.

Although many air monitoring sites rarely encounter pollutant concentrations at the higher audit sample levels, these concentrations are included to assure that monitoring methods are verified at the higher levels.

The following paragraphs describe each sample type used in the 1985 audits.

SULFUR DIOXIDE (MANUAL)

Lyophilized samples, composed of sodium sulfite and potassium tetrachloromercurate, simulate ambient air samples collected according to the Pararosaniline Method, the reference method for determining SO_2 in the atmosphere. In the 1985 audits, the concentrations ranged from approximately 45 to 270 µg of sulfur dioxide equivalent per cubic meter when reconstituted properly. A sample set consisted of five different concentrations. (This audit is being discontinued due to the small number of participants.)

NITROGEN DIOXIDE (MANUAL)

Nitrogen dioxide samples consist of aqueous sodium nitrite solutions that simulate ambient NO_2 samples collected by a 24-hour NO_2 bubbler method. Audit results are expressed in terms of micrograms per milliliter (nitrite concentration). These solutions, when properly diluted according to directions, are equivalent to collected atmospheric NO_2 concentrations of approximately 0.3 to 1.1 µg/mL. A sample set consists of five different concentrations.

CARBON MONOXIDE

These audit materials consist of a mixture of CO, CO_2 and CH_4 and zero air in a disposable pressurized gas cylinder that simulates an ambient air

sample. The concentrations of the three CO samples used in the 1985 audits ranged from 7 to 40 ppm. Directions specify that the gas sample be introduced into a continuous analyzer in the "sample" mode, which permits the analyzer to draw the sample in the same fashion and at the same flow rate as during ambient air monitoring.

SULFATE, NITRATE, AND LEAD ON FILTER STRIPS

The filter strip samples used in sulfate, nitrate and lead audits are each 1.9 cm wide by 20 cm long. They are cut from 20- by 24-centimeter glass fiber filters that have been spiked with an aqueous solution of the appropriate solution and then oven dried. After analysis, pollutant concentrations are computed by assuming that the samples were collected on the prescribed high-volume filter with a sample air volume of 2,000 m^3. Six sample strips comprise a set.

Sulfate and nitrate audit samples are prepared from sodium sulfate and potassium nitrate. Calculated nitrate concentrations ranged from 0.66 to 14.0 $\mu g/m^3$ and sulfate from 1.6 to 26.0 $\mu g/m^3$. Lead samples, which are prepared from lead nitrate ranged in concentration from 0.45 to 6.7 $\mu g/m^3$ of lead.

HIGH-VOLUME FLOW RATE (ReF DEVICE)

The reference flow (ReF) device used for audits of high-volume flow rates consist of a modified orifice, a wind deflector, a manometer, and a series of resistance plates that simulate particulate loading. A single ReF device is supplied to each participating agency with instructions to check samplers at as many sampling sites as feasible within the allotted time.

Before use in the audit each ReF device is calibrated with a positive displacement meter traceable to NBS. During the audit, the device is mounted on top of the sampler, replacing the filter face plate. A wind deflector is used to prevent fluctuations in the measurements due to wind blowing across the orifice.

SULFUR DIOXIDE CONTINUOUS MONITORS

The continuous monitor auditing system is an auditing device for SO_2 continuous ambient air monitors. The device is a porous plug dilution system that provides a mechanism whereby controlled quantities of SO_2 and diluent air are continuously combined in a mixing chamber and passed into the monitor. The flow rate of each gas is controlled by maintaining a predetermined pressure drop across the porous plus flow restrictor. Variable SO_2 concentrations are obtained by switching between four restrictors.

The audit device, which is housed in a compact, lightweight, impact-resistant case, is constructed so that only those controls required for system operation are exposed. By opening and closing different toggle valves, it is possible to generate up to seven preset pollutant concentrations. Five are used for the audit. Two compressed gas cylinders are

supplied with each unit, one as the pollutant source and the other for dilution.

Each audit device is calibrated for flow at all the settings used in the audit. Flow calibrations are referenced to laminar flow elements traceable to National Bureau of Standards flow standards. Sulfur dioxide concentrations ranging from 0.0 to 0.9 ppm were used in the 1985 audits.

ACID RAIN

Five aqueous solutions in polyethylene bottles containing the anions and cations found in rain water were shipped to each of the participating laboratories. All samples were diluted 1:50 by the participant. Three samples were then analyzed for pH, conductivity, acidity and the major cations and anions normally measured in precipitation samples and the other two for heavy metals. The latter two samples were acid stabilized in the concentrate form to prevent loss of metals from the solution.

The chemical composition of these samples was certified by the U.S. National Bureau of Standards. The participants analyzed the samples using the analytical procedures they normally employ when analyzing their precipitation samples. The results were reported based on the sample concentration after the 1:50 dilution.

SECTION 4

AUDIT RESULTS

The results of the 1984 audit are presented in Tables 2 through 31. The term "audit mean" in these tables denotes the average of all values reported by the participants for that sample after elimination of outliers. Elimination of outliers was accomplished in a two step procedure. First, results from laboratories/sites whose values for all samples exceeded ± 20 percent of the assigned value were removed from the data base. These excluded values represented 5.7 percent of the total number of laboratories/sites reporting results which is approximately the same as for 1982 through 1984 (1, 2, 3). Then, individual sample results were rejected as outliers based on Chauvenet's Criterion (4). After eliminating outliers, the results from all participants were found to be normally distributed which was expected based on experience (1, 2, 3).

At each audit level, the percent accuracy (% Acc.) and the precision, as measured by the percent coefficient of variation (%CV), were calculated using Equations 1 and 2, respectively. The percent accuracy measures how well the average of all participants agrees with EPA's assigned values. The percent coefficient of variation measures the variability among participants.

$$\% \text{ Acc.} = \frac{\text{audit mean} - \text{EPA assigned value}}{\text{EPA assigned value}} \times 100 \qquad (1)$$

$$\% \text{ CV} = \frac{\text{audit standard deviation}}{\text{audit mean}} \times 100 \qquad (2)$$

Overall accuracy and precision values for each audit were also calculated and plotted (Figures 1 through 25) to show the historical record of performance for each type of audit. All of the figures present the results of the performance audits <u>after</u> elimination of the outliers. Many readers may find that scanning these figures provides a better understanding of the 1985 results compared to scanning the tabulated results and reading the text of this report.

SULFUR DIOXIDE (BUBBLER)

Twelve laboratories participated in the audit -- 40 percent less than in 1984 (1). Participation has steadily decreased since 1981 due to the increasing number of laboratories changing to automated analyzers. Because of the low level of participation, this audit is being discontinued.

The audit mean, percent accuracy and percent CV, with and without outliers, are reported in Table 2. As usual the lowest precision and accuracy was achieved in level one. Overall, however, the average percent accuracy appears to have stabilized over the past five audits when compared to audits of previous years (Figure 1). Precision has continued to improve (Figure 1).

As shown in Table 3, accuracy for the manual pararosaniline method, ranged from -2.14 to 7.16% for all data after outliers are removed. Accuracy for the automated method ranged from -0.43 to 6.04% for all data after outliers were removed. As before (1, 2, 3) sample concentration did not appear to affect the precision for either method.

Table 4, constructed with the outliers removed, shows the percentage of laboratories that obtained results within ± 10, 20, 30 and 50 percent of the assigned values. Better than 92 percent of the measurements fell within 20 percent of the assigned values, a greater percentage than 1984 (90%), 1983 (87%), and 1982 (88%).

NITROGEN DIOXIDE

Eighteen laboratories participated in the 1985 audit — 15% less than in 1984 (1). The decrease, which occurred among the state and local participants, likely resulted because an increasing number of laboratories are replacing bubblers with continuous analyzers. Because of the low level of participation, this audit is being discontinued.

The audit mean, percent accuracy and percent CV with and without outliers are reported in Tables 5 and 6. Figure 2 shows that with a few exceptions the precision and accuracy over the years has been good.

CARBON MONOXIDE

In 1985, 323 monitors were audited — a 1.5% decrease from 1984. Eighty-six percent of the monitors audited were NDIR compared to 95% in 1984 (1) and 1983 (2). This decrease was offset by a large increase in gas filter correlation CO monitors. However, the small number of these latter monitors used in the 1984 audit prevents a meaningful comparison from being made between 1984 and 1985.

As shown in Figure 3, both precision and accuracy have stayed at the same level for the last six years. Also, the number of measurements falling within 20% of the assigned value (Table 10) closely parallels the 1982 through 1984 results (1, 2, 3). Also, as shown in Figure 3, the accuracy has oscillated back and forth across the zero-axis for the last five years.

SULFATE ON FILTER STRIPS

Approximately 55 laboratories participated in each audit. The audit mean, percent accuracy and precision are given in Table 11. Over the years accuracy has varied quite a bit, but now it seems to have stabilized (Figure 4). Precision has also stabilized after improving continually for several years.

As in 1984, there also is no apparent relationship between concentration and either precision or accuracy for the manual and for the automated methods (Table 13).

Except for the lowest sample concentration, between 72 and 100 percent of the laboratories reported results within ± 20 percent of the assigned values (Table 14) -- about the same as in 1984 (1).

NITRATE ON FILTER STRIPS

Approximately 45 laboratories participated in each 1985 audit. Participation was down approximately 2 percent from 1984. As in the sulfate audits, the number of participants has been fairly constant since 1979. Both accuracy and precision seem to have reached a plateau with no improvement evident for the last couple of years (Figure 5).

The results from the 1985 nitrate audits show a slight increase in both precision and accuracy with respect to the 1984 audits (Figure 5, Table 15). This increase occurred in the automated methods (Table 16), more so than in the manual analytical methods.

Some other methods used by a few of the participants included the manual cadmium reduction, brucine, hydrazine, 2,4 xylenol, selective ion electrode, and the szechrome NAS methods. The number of results reported was too small to calculate precision and accuracy.

The percentage of values that fell within ± 20 percent of the assigned values (Table 17) was higher (90%) than in 1984 (84%) and identical to that for 1983 and 1982 (90%).

LEAD ON FILTER STRIPS

One hundred and seven laboratories participated in the 0185 audit and 102 in the 0785, a 2 percent increase over the 1984 audits. The increase was due to an increase in participation from local agencies. Participation has leveled off in the past three years, ranging from 95 to 107 laboratories per audit.

The audit mean, percent accuracy and percent CV (precision) are shown in Table 18. Accuracy has continued to show the negative bias present since the audits were initiated in 1977, but the bias was considerably less than for the period 1982-1984 (Figure 6). Precision has remained at the same level since 1982 (Figure 6) and in 1985, the number of measurements within ± 20 percent of the assigned value (97%) was the same as in 1984 (1) and 1983 (2) (Table 19). This year all participants used atomic absorption for sample analysis.

SULFUR DIOXIDE (CONTINUOUS MONITORS)

The number of monitors audited totaled 257 (Table 20). Compared to 1984, this increase of 16 percent resulted mainly from an equal increase in participation by both state and local agencies.

The accuracy for each of the methods is shown in Table 21. The methods most commonly used were: fluorescence (243), flame photometric (7) and coulometric (4). In relation to 1984, these numbers represent a 19% increase, 16% decrease and 20% decrease, respectively. The decrease in the number of flame photometric and coulometric analyzers and the large increase in the number of fluorescent analyzers continues the shift in user preference for the fluorescence monitor observed earlier (1, 2). The accuracy of the fluorescent improved compared to 1984 (1), but the accuracy of the other two types decreased slightly.

HIGH VOLUME

The number of monitors audited in 1985 was 1336 -- a 4% decrease from 1984 (1). The pressure transducer continued to be the most widely used method of measurement (50.3%), the rotameter was next (20.8%), followed by the flow controller (4.1%). Other methods which accounted for the remaining 24.8 percent of the results, included: orifice manometer, manometer, flow gauge, and pressure transducer/non-continuous. Table 22 shows the percentage of the flow measurements within ± 10, 20, 30 and 50% of the true value for each resistance plate used in the ReF (audit) device. These results are similar to the 1984 (1) and 1983 (2) results.

ACID RAIN

Thirty-three laboratories participated in the 0485 audit and thirty-three participated in the 1185 audit. Overall this represents a 6% decrease in participation compared to 1984. Because of the short history of this audit, it is possible at this time to make only general observations concerning time trends. Also, because of the low concentrations present in some of the samplers, the relative precision sometimes appears as poor, when, in absolute terms (e.g., mg/l) the precision is reasonably good.

Results for pH, Conductivity and Acidity

The results are presented in Table 24 (all data), Table 25 (outliers removed) and in Figures 7 (pH), 8 (conductivity) and 9 (acidity). As in the earlier audits (1, 2, 3), there is, at best, only a weak correlation apparent between sample concentration and precision and accuracy. This is very different from the ambient air audits reported earlier where precision and accuracy generally correlate with concentration. For both pH and acidity, precision and accuracy have remained essentially the same (Figures 7 and 8, respectively). On the other hand, the accuracy of the acidity measurement has varied widely (Figure 9) and precision continues to improve but in an erratic manner.

Major Anions Results (SO_4, NO_3, Cl, F)

The results for these four parameters are presented in Table 26 (all data), Table 27 (outliers removed) and in Figures 10 (SO_4), 11 (NO_3), 12 (Cl) and 13 (F). As in the past, precision continued to exceed 10 percent in all audits and also remained erratic. As shown by comparing the precision in Tables 26 and 27, however, removal of only a few results yields a large improvement in precision. Thus, the results are not as poor as they appear.

Major Cations (NH_4, Ca, K, Mg, Na)

The results for these five major ions are presented in Table 28 (all data), Table 29 (outliers removed) and in Figures 14 (NH_4), 15 (Ca), 16 (K), 17 (Mg) and 18 (Na). As in the case for the major anions, the precision has been erratic for all five anions over the history of the audit. But, as in the case for the major anions, removing just one or two values yields a dramatic improvement in precision.

Trace Metals Results (Mn, Fe, Cd, Cu, Ni, Pb, Zn)

The results for these seven metals are presented in Table 30 (all data), Table 31 (outliers removed) and in Figures 19 (Mn), 20 (Fe), 21 (Cd), 22 (Cu), 23 (Ni), 24 (Pb), and 25 (Zn). Also as in the case of both the anions and cations, the precision has varied in an erratic manner for most of these metals (Zn continues to be the exception). It should be borne in mind, however, that the small concentrations used for these metals does mean that a small absolute difference appears as a large relative difference.

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TABLE 1. AGENCY PARTICIPATION

Survey	Distribution (%)					No. of Laboratories[a]	No. of Monitors[a]
	States	Local	Industry	Federal	Foreign		
SO_2 -- June 1985	42.0	33.0	25.0	0.0	0.0	12 (0)	--
NO_2 -- June 1985	33.3	44.4	22.3	0.0	0.0	18 (0)	--
CO -- May 1985	52.0	41.8	2.5	1.5	2.1	--	325 (11)
SO_4 -- February 1985	51.8	13.8	24.1	1.7	8.6	58 (0)	--
SO_4 -- August 1985	45.8	16.7	20.8	4.2	12.5	51 (2)	--
NO_3 -- February 1985	52.2	12.5	25.0	2.0	8.3	48 (2)	--
NO_3 -- August 1985	52.4	11.9	19.0	2.4	14.3	42 (2)	--
Pb -- January 1985	40.2	26.2	27.1	1.9	4.9	107 (5)	--
Pb -- July 1985	42.2	28.4	24.5	2.0	2.9	102 (2)	--
SO_2 (continuous)	58.4	40.5	0.0	00.1	0.0	--	257 (2)
High-Volume Flow-Rate -- May 1985	38.5	44.8	14.2	0.5	2.0	--	1336 (113)
Acid Rain -- April 1985	42.4	12.1	30.3	15.1	0.0	33	--
Acid Rain -- October 1985	39.4	12.1	33.3	15.1	0.0	33	--

[a]Value in parentheses is the number of laboratories/monitors that reported all values off by more than ± 20% from the true value.

TABLE 2. AUDIT RESULTS FOR MANUAL SULFUR DIOXIDE METHOD (BUBBLER)

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0685	1	12	44.30	43.60	-1.58	14.06
	2	12	61.00	62.55	2.54	9.40
	3	12	90.60	96.75	6.79	7.43
	4	12	124.50	128.97	3.59	6.09
	5	12	271.90	279.05	2.63	7.15
			B. OUTLIERS REMOVED			
0685	1	12	44.30	43.60	-1.58	14.06
	2	11	61.00	61.06	0.10	4.83
	3	11	90.60	95.30	5.19	5.66
	4	12	124.50	128.97	3.59	6.09
	5	11	271.90	274.69	1.03	4.98

TABLE 3. RESULTS FOR THE PARAROSANILINE METHOD

Audit	Level	Assigned value ($\mu g/m^3$)	Manual Method (01) n	Manual Method (01) Mean ($\mu g/m^3$)	Manual Method (01) % Acc.	Manual Method (01) % CV	Automated Method (02) n	Automated Method (02) Mean ($\mu g/m^3$)	Automated Method (02) % Acc.	Automated Method (02) % CV
					A. ALL DATA					
0685	1	44.30	8	43.35	-2.14	17.23	4	44.11	-0.43	5.96
	2	61.00	8	63.18	3.57	11.44	4	61.29	0.48	2.03
	3	90.60	8	97.09	7.16	8.49	4	96.07	6.04	5.71
	4	124.50	8	130.61	4.91	6.51	4	125.68	0.91	4.74
	5	271.90	8	282.89	4.04	7.63	4	271.38	-0.19	5.89
					B. OUTLIERS REMOVED					
0685	1	44.30	8	43.35	-2.14	17.23	4	44.11	-0.43	5.96
	2	61.00	7	60.93	-0.11	6.07	4	61.29	0.48	2.03
	3	90.60	8	97.09	7.16	8.49	4	96.07	6.04	5.71
	4	124.50	8	130.61	4.91	6.51	4	125.68	0.91	4.74
	5	271.90	8	282.89	4.04	7.63	4	271.38	-0.19	5.89

TABLE 4. PERCENT OF SULFUR DIOXIDE MEASUREMENTS WITHIN INDICATED PERCENT OF ASSIGNED VALUES

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
0685	1	43.60	50.0	83.3	100.0	100.0
	2	61.00	91.7	91.7	100.0	100.0
	3	90.60	75.0	91.7	100.0	100.0
	4	124.50	83.3	100.0	100.0	100.0
	5	271.90	91.7	91.7	100.0	100.0

TABLE 5. AUDIT RESULTS FOR NITROGEN DIOXIDE MANUAL METHOD (BUBBLER)

Audit	Level	n	Assigned value (µg/ml)	Mean (µg/ml)	% Acc.	% CV
			A. ALL DATA			
0685	1	18	0.345	0.353	2.32	8.78
	2	18	0.434	0.442	1.14	3.62
	3	18	0.686	0.698	1.31	3.02
	4	17	0.944	0.908	3.81	13.88
	5	16	1.114	1.119	0.45	4.83
			B. OUTLIERS REMOVED			
0685	1	17	0.345	0.346	0.29	3.18
	2	16	0.437	0.442	1.14	2.49
	3	18	0.686	0.695	1.31	3.02
	4	16	0.944	0.938	-0.64	2.13
	5	15	1.114	1.131	1.53	2.39

TABLE 6. AUDIT RESULTS FOR NITROGEN DIOXIDE BY THE SODIUM ARSENITE METHOD

Audit	Level	Assigned value (µg/mL)	Manual Method (05) n	Manual Method (05) Mean (µg/mL)	Manual Method (05) % Acc.	Manual Method (05) % CV	Automated Method (06) n	Automated Method (06) Mean (µg/mL)	Automated Method (06) % Acc.	Automated Method (06) % CV
				A. ALL DATA						
0685	1	0.345	13	0.355	2.90	10.14	4	0.348	0.87	1.44
	2	0.437	13	0.440	0.69	4.32	4	0.449	2.75	1.33
	3	0.686	13	0.691	0.73	3.04	4	0.705	7.77	3.26
	4	0.944	12	0.893	-5.40	16.69	4	0.940	0.21	2.11
	5	1.114	11	1.104	-0.90	5.25	4	1.152	3.41	1.74
				B. OUTLIERS REMOVED						
0685	1	0.345	12	0.346	0.29	3.47	4	0.348	0.87	1.44
	2	0.437	12	0.436	0.23	3.44	4	0.479	2.75	1.33
	3	0.686	13	0.691	0.73	3.04	4	0.705	2.77	3.26
	4	0.944	11	0.935	-0.95	2.25	4	0.940	0.21	2.11
	5	1.114	10	1.120	0.54	2.14	4	1.152	3.41	1.74

TABLE 7. PERCENT OF NITROGEN DIOXIDE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value (µg/mL)	10%	20%	30%	50%
0685	1	0.345	94.4	94.4	94.4	100.0
	2	0.437	100.0	100.0	100.0	100.0
	3	0.686	100.0	100.0	100.0	100.0
	4	0.944	88.9	88.9	88.9	88.9
	5	1.114	83.3	88.9	88.9	88.9

TABLE 8. AUDIT RESULTS FOR CARBON MONOXIDE

Audit	Level	n	Assigned value (ppm)	Mean (ppm)	% Acc.	% CV
			A. ALL DATA			
0585	1	323	6.70	6.91	3.13	42.55
	2	326	16.50	16.60	0.61	11.08
	3	317	39.90	40.08	0.45	11.38
			B. OUTLIERS REMOVED			
0585	1	309	6.70	6.65	-0.75	7.67
	2	310	16.50	16.51	0.06	3.27
	3	304	39.90	40.09	0.48	3.19

TABLE 9. AUDIT RESULTS FOR CARBON MONOXIDE BY THE NDIR METHOD

Audit	Level	Assigned value (ppm)	NDIR n	NDIR Mean (ppm)	NDIR % Acc.	NDIR % CV
		A. ALL DATA				
0585	1	6.70	278	6.75	0.75	46.82
	2	16.50	281	16.58	0.48	8.02
	3	39.90	273	39.96	0.15	10.04
		B. OUTLIERS REMOVED				
0585	1	6.70	269	6.66	-0.59	7.96
	2	16.50	269	16.56	0.36	3.20
	3	39.90	265	40.11	0.53	3.29

TABLE 10. PERCENT OF CARBON MONOXIDE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value (ppm)	10%	20%	30%	50%
		A. ALL DATA				
0585	1	6.70	85.0	96.0	97.2	98.1
	2	16.50	95.1	99.3	99.7	99.7
	3	39.90	92.3	96.3	96.3	96.3
		B. OUTLIERS REMOVED				
0585	1	6.70	88.5	97.8	98.1	98.4
	2	16.50	98.1	100.0	100.0	100.0
	3	39.90	95.2	97.1	97.1	97.1

TABLE 11. AUDIT RESULTS FOR SULFATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0285	1	54	1.55	1.69	9.03	34.32
	2	56	3.06	2.98	-2.61	16.44
	3	58	10.79	10.46	-3.06	7.65
	4	58	8.68	8.71	0.35	12.17
	5	58	19.25	18.93	-1.66	10.94
	6	58	24.09	23.48	-2.53	6.43
0885	1	50	2.09	2.79	33.49	81.72
	2	50	3.60	3.80	5.56	26.05
	3	51	11.81	11.57	-2.03	15.56
	4	51	26.05	25.34	-2.73	12.63
	5	51	18.65	18.08	-3.06	17.70
	6	51	5.08	5.22	2.76	19.73
			B. OUTLIERS REMOVED			
0285	1	54	1.55	1.69	9.03	34.32
	2	55	3.06	2.95	-3.59	14.92
	3	57	10.79	10.50	-2.69	7.14
	4	55	8.68	8.63	-0.58	8.46
	5	57	19.25	18.77	-2.49	8.90
	6	57	24.09	23.58	-2.12	5.60
0885	1	47	2.09	2.45	17.22	42.86
	2	45	3.60	3.59	-0.28	7.74
	3	47	11.81	11.83	0.17	6.85
	4	47	26.05	26.50	1.73	5.25
	5	48	18.65	18.50	-0.70	6.48
	6	48	5.08	5.24	3.15	13.36

TABLE 12. AUDIT RESULTS FOR SULFATE BY THE MANUAL METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	$BaCl_2$ (17) n	$BaCl_2$ (17) Mean ($\mu g/m^3$)	$BaCl_2$ (17) % Acc.	$BaCl_2$ (17) % CV	Sulfa-Ver (19) n	Sulfa-Ver (19) Mean ($\mu g/m^3$)	Sulfa-Ver (19) % Acc.	Sulfa-Ver (19) % CV
				A. ALL DATA						
0285	1	1.55	9	2.21	45.58	35.75	1	1.34	-13.58	0.00
	2	3.06	9	3.48	13.73	20.98	2	2.69	-12.89	4.46
	3	10.79	9	10.20	-5.46	12.25	3	11.13	3.18	9.61
	4	8.68	9	9.13	5.18	23.22	3	9.03	4.03	4.65
	5	19.25	9	18.80	-2.34	13.88	3	19.40	0.78	8.81
	6	24.09	9	23.48	-2.53	7.62	3	23.40	-2.86	12.05
0885	1	2.09	6	3.20	53.11	46.88	2	3.45	65.07	116.81
	2	3.60	6	4.33	20.28	35.56	2	4.20	16.67	80.71
	3	11.81	6	10.84	-8.21	31.83	2	11.85	0.34	1.77
	4	26.05	6	22.59	-13.38	32.23	2	24.20	-7.10	12.27
	5	18.65	6	16.61	-10.94	30.10	2	18.70	0.27	5.29
	6	5.08	6	5.20	2.36	27.12	2	4.75	-6.50	72.84
				B. OUTLIERS REMOVED						
0285	1	1.55	9	2.21	42.58	35.75	1	1.34	-13.55	0.00
	2	3.06	9	3.48	13.73	20.98	2	2.69	-12.09	4.46
	3	10.79	9	10.20	-5.46	12.25	3	11.13	3.15	9.61
	4	8.68	9	9.13	5.18	23.22	3	9.03	4.03	4.65
	5	19.25	9	18.80	-2.34	13.88	3	19.40	0.78	8.81
	6	24.09	9	23.48	-2.53	7.62	3	23.40	-2.80	12.05
0885	1	2.09	5	3.33	59.33	30.56	2	3.45	65.07	116.81
	2	3.60	5	4.68	30.00	30.56	2	4.20	16.67	80.71
	3	11.81	5	12.20	3.30	8.85	2	11.85	0.34	1.72
	4	26.05	5	25.51	2.07	5.80	2	24.20	-7.10	12.27
	5	18.65	5	18.61	-0.21	5.96	2	18.70	0.27	5.29
	6	5.08	5	5.66	11.42	16.43	2	4.75	6.50	72.84

TABLE 13. AUDIT RESULTS FOR SULFATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Methyl Thymol Blue (16) n	Mean ($\mu g/m^3$)	% Acc.	% CV	Ion Chromatograph (34) n	Mean ($\mu g/m^3$)	% Acc.	% CV
				A. ALL DATA						
0285	1	1.55	26	1.64	5.81	32.93	16	1.53	-1.29	24.18
	2	3.06	27	2.87	-9.22	14.63	16	2.91	-4.90	10.65
	3	10.79	28	10.45	-3.15	6.79	16	10.44	-3.24	5.75
	4	8.68	28	8.69	0.12	9.32	16	8.38	-3.46	7.04
	5	19.25	28	19.23	-0.10	11.80	16	18.45	-4.16	8.46
	6	24.09	28	23.26	-0.01	4.71	16	22.95	-4.73	7.71
0885	1	2.09	22	2.09	41.63	106.08	16	2.08	-0.48	16.83
	2	3.60	22	3.82	5.56	20.42	16	3.45	-4.17	7.83
	3	11.81	23	12.04	2.29	10.38	16	10.99	-7.46	15.92
	4	26.05	23	26.15	0.38	8.72	16	25.27	-2.99	7.72
	5	18.65	23	18.26	-2.09	21.14	16	17.29	-3.91	7.92
	6	5.08	23	5.36	5.51	18.10	16	4.99	-1.77	12.02
				B. OUTLIERS REMOVED						
0285	1	1.55	25	1.58	1.94	30.38	15	1.45	-6.45	13.10
	2	3.06	26	2.91	-4.90	12.37	14	2.90	-5.23	5.52
	3	10.79	26	10.60	-1.76	4.06	15	10.53	-2.41	4.75
	4	8.68	26	8.50	-2.07	4.47	15	8.49	-2.19	5.60
	5	19.25	27	18.90	-1.82	7.78	15	18.70	-2.86	6.58
	6	24.09	26	23.74	-1.45	3.37	15	23.29	-3.32	5.11
0885	1	2.09	20	2.18	4.31	13.70	14	1.96	-6.22	7.14
	2	3.60	20	3.61	0.28	8.03	15	3.49	-3.06	6.30
	3	11.81	22	11.84	0.25	6.67	15	11.36	-3.81	8.54
	4	26.05	22	25.79	-1.00	5.97	14	25.18	-3.34	2.79
	5	18.65	21	18.72	0.38	4.81	15	18.15	-3.22	6.17
	6	5.08	21	5.12	0.79	7.81	15	4.87	-4.13	7.80

TABLE 14. PERCENT OF SULFATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0285	1	1.55	39.7	65.5	70.7	77.5
	2	3.06	53.4	77.6	91.4	89.7
	3	10.79	82.8	94.8	100.0	100.0
	4	8.68	81.0	89.7	93.1	100.0
	5	19.25	72.4	93.1	98.3	100.0
	6	24.09	86.2	98.3	100.0	100.0
0885	1	2.09	45.1	62.7	68.6	76.5
	2	3.60	54.9	72.5	84.3	86.3
	3	11.81	78.4	90.2	92.2	96.1
	4	26.05	84.3	96.1	96.1	98.0
	5	18.65	86.3	92.2	92.2	96.1
	6	5.08	66.7	80.4	88.2	96.1
		B. OUTLIERS REMOVED				
0285		Same As For All Data				
0885	1	2.09	46.9	65.3	69.4	77.6
	2	3.60	57.1	75.5	85.7	87.8
	3	11.81	81.6	93.9	95.9	98.0
	4	26.05	87.8	100.0	100.0	100.0
	5	18.05	89.8	95.9	98.0	98.0
	6	5.08	69.4	83.7	91.8	98.0

TABLE 15. AUDIT RESULTS FOR NITRATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0285	1	47	0.66	0.68	3.03	25.00
	2	47	1.92	1.94	1.04	24.74
	3	48	4.76	4.71	-1.05	20.81
	4	48	8.32	8.09	-2.76	17.68
	5	48	10.69	10.53	-1.50	17.85
	6	48	13.18	12.71	-3.57	17.62
0885	1	41	0.74	0.99	25.25	131.31
	2	41	2.15	2.05	-4.65	24.88
	3	42	5.34	5.19	-2.81	20.81
	4	42	9.72	9.33	-4.18	20.90
	5	42	11.44	10.68	-6.64	25.47
	6	42	13.43	12.84	-4.39	20.02
			B. OUTLIERS REMOVED			
0285	1	43	0.66	0.70	6.06	15.71
	2	43	1.92	1.93	0.52	8.29
	3	44	4.76	4.86	2.09	5.14
	4	45	8.32	8.33	0.12	5.64
	5	45	10.69	10.82	1.22	7.12
	6	44	13.18	13.00	-1.37	5.62
0885	1	38	0.74	0.81	9.46	37.04
	2	37	2.15	2.13	-0.93	10.80
	3	37	5.34	5.43	1.69	6.26
	4	38	9.72	9.71	-0.10	7.00
	5	39	11.44	11.37	-0.61	8.62
	6	38	12.43	13.39	-0.30	4.93

TABLE 16. AUDIT RESULTS FOR NITRATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Ion Chromatograph (34) n	Mean ($\mu g/m^3$)	% Acc.	% CV	Cadmium Reduction (12) n	Mean ($\mu g/m^3$)	% Acc.	% CV
				A. ALL DATA						
0285	1	0.66	14	0.74	12.12	20.27	19	0.67	1.52	20.90
	2	1.92	14	1.88	-2.08	5.85	19	2.15	11.98	24.65
	3	4.76	14	4.77	0.21	6.29	20	4.88	2.52	19.06
	4	8.32	14	8.33	0.12	7.32	20	8.33	0.12	6.12
	5	10.69	14	10.69	0.00	8.33	20	11.02	3.09	6.53
	6	13.18	14	13.17	-0.08	7.06	20	13.33	1.14	6.08
0885	1	0.74	16	0.88	18.92	40.91	15	0.69	-6.76	34.78
	2	2.15	16	2.18	1.40	10.10	15	1.91	-11.16	25.65
	3	5.34	16	5.26	-1.50	10.65	16	5.16	-3.37	20.54
	4	9.72	16	9.47	-2.57	7.29	16	9.31	-4.22	21.05
	5	11.44	16	11.14	-2.62	7.27	16	10.75	-6.03	19.91
	6	13.43	16	13.32	-0.82	8.03	16	12.72	-5.29	20.13
				B. OUTLIERS REMOVED						
0285	1	0.66	13	0.70	6.06	10.00	18	0.69	4.55	19.49
	2	1.92	13	1.90	-1.04	4.74	17	1.98	3.13	5.56
	3	4.76	13	4.82	1.26	4.98	18	4.86	2.10	5.35
	4	8.32	13	8.21	-1.32	5.48	20	8.33	0.12	6.12
	5	10.69	13	10.52	-1.59	6.18	19	10.89	1.87	6.98
	6	13.18	13	12.96	-1.67	4.09	19	13.19	0.08	4.17
0885	1	0.74	15	0.80	8.11	26.25	13	0.76	2.70	17.11
	2	2.15	15	2.14	-0.47	7.01	13	2.09	-2.79	6.22
	3	5.34	14	5.44	1.87	4.78	14	5.33	-0.19	5.44
	4	9.72	15	9.60	1.23	4.69	13	9.76	0.41	4.61
	5	11.44	15	11.27	-1.49	5.50	15	11.28	-1.40	3.90
	6	13.43	15	13.54	0.82	4.80	15	13.35	-0.60	3.90

TABLE 17. PERCENT OF NITRATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0285	1	0.66	43.7	66.7	81.3	89.6
	2	1.92	72.9	87.5	87.5	89.6
	3	4.76	81.3	91.7	91.7	91.7
	4	8.32	85.4	95.8	95.8	95.8
	5	10.69	79.2	89.6	95.8	95.8
	6	13.18	85.4	91.7	95.8	95.8
0885	1	0.74	47.6	59.5	66.7	85.7
	2	2.15	66.7	81.0	85.7	90.5
	3	5.34	78.6	88.1	95.2	95.2
	4	4.72	73.8	90.5	95.2	95.2
	5	11.44	81.0	88.1	90.5	92.9
	6	13.43	85.7	92.9	95.2	95.2
		B. OUTLIERS REMOVED				
0285	1	0.66	45.7	69.6	84.8	93.5
	2	1.92	76.1	91.3	91.3	93.5
	3	4.76	84.8	95.7	95.7	95.7
	4	8.32	88.4	100.0	100.0	100.0
	5	10.69	82.6	93.5	100.0	100.0
	6	13.18	89.1	95.7	100.0	100.0
0885	1	0.74	50.0	62.5	70.0	85.0
	2	2.15	70.0	85.0	90.0	95.0
	3	5.34	82.5	92.5	100.0	100.0
	4	4.72	77.5	95.0	100.0	100.0
	5	11.44	85.0	92.5	95.0	97.5
	6	13.43	90.0	97.5	100.0	100.0

TABLE 18. AUDIT RESULTS FOR LEAD ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0185	1	107	0.53	0.52	-1.89	9.62
	2	107	1.06	1.05	-0.94	8.57
	3	107	3.03	2.96	-2.31	6.42
	4	107	4.31	4.10	-4.87	6.34
	5	106	4.83	4.73	-2.07	7.19
	6	107	6.65	6.40	-3.76	5.78
0785	2	102	0.45	0.50	11.11	70.00
	3	102	1.00	1.00	0.00	8.00
	4	102	1.15	1.12	-2.61	8.04
	5	102	2.00	1.99	-0.50	8.04
	6	101	2.70	2.76	2.22	12.68
	7	100	5.40	5.23	-3.15	11.47
			B. OUTLIERS REMOVED			
0185	1	100	0.53	0.52	-1.89	7.69
	2	100	1.06	1.06	0.00	5.66
	3	102	3.03	2.95	-2.64	3.73
	4	101	4.31	4.13	-4.18	3.87
	5	99	4.83	4.77	-1.24	3.77
	6	100	6.65	6.44	-3.16	3.42
0785	2	98	0.45	0.46	2.22	10.87
	3	99	1.00	1.01	1.00	6.93
	4	98	1.15	1.13	-1.74	7.08
	5	96	2.00	2.01	0.50	5.97
	6	97	2.70	2.74	1.48	6.20
	7	95	5.40	5.34	-1.11	6.55

TABLE 19. PERCENT OF LEAD MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0185	1	0.53	83.1	92.5	97.2	100.0
	2	1.06	84.1	97.2	99.1	100.0
	3	3.03	91.6	99.1	99.1	100.0
	4	4.31	88.8	97.2	98.1	100.0
	5	4.83	88.8	95.3	97.2	99.1
	6	6.65	92.5	99.1	99.1	100.0
0785	2	0.45	70.6	90.2	94.1	97.1
	3	1.00	82.3	99.0	99.0	100.0
	4	1.15	83.3	96.1	99.0	100.0
	5	2.00	84.0	95.1	99.0	100.0
	6	2.70	81.4	94.1	97.1	97.1
	7	5.40	82.3	92.2	94.1	91.1
		B. OUTLIERS REMOVED				
0185	1	0.53	87.3	95.1	100.0	100.0
	2	1.06	88.2	98.0	99.0	100.0
	3	3.03	96.1	100.0	100.0	100.0
	4	4.31	93.1	99.0	99.0	100.0
	5	4.83	93.1	97.0	98.0	99.0
	6	6.65	97.0	100.0	100.0	100.0
0785	2	0.45	72.0	91.0	95.0	97.0
	3	1.00	84.0	99.0	99.0	100.0
	4	1.15	85.0	97.0	99.0	100.0
	5	2.00	86.0	96.0	99.0	100.0
	6	2.70	83.0	95.0	97.0	97.0
	7	5.40	84.0	93.0	95.0	96.0

TABLE 20. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS (ALL DATA)

Flow setting	Number of reported values*	Range of values (ppm)	Mean differences ppm	Mean differences % diff.	Standard deviation (ppm)
1	32	0.468 to 0.866	-0.011	-1.8	0.060
2	242	0.234 to 0.653	0.006	1.5	0.036
3	255	0.126 to 0.457	0.006	2.6	0.027
4	255	0.100 to 0.331	0.004	1.9	0.016
5	253	0.030 to 0.108	0.002	3.4	0.007
6	181	-0.006 to 0.060	0.001	---	0.005

*1985 Audit: Data returned for 257 monitors

TABLE 21. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS BY VARIOUS INSTRUMENTAL METHODS

Flow setting	Flame photometric average difference n	Flame photometric average difference ppm	Flame photometric average difference %	Fluorescent average difference n	Fluorescent average difference ppm	Fluorescent average difference %	Coulometric average difference n	Coulometric average difference ppm	Coulometric average difference %
1	0	---	---	31	-0.005	-1.0	0	---	---
2	6	0.007	2.1	231	0.007	1.6	4	-0.020	-4.3
3	7	0.002	0.9	243	0.007	2.8	4	-0.002	-0.7
4	7	0.000	0.0	243	0.004	2.1	4	0.0	-0.4
5	7	0.001	1.1	242	0.002	3.5	4	0.0	0.2
6	7	0.001	---	169	0.001	---	4	0.004	---

TABLE 22. PERCENT OF HI-VOL FLOW MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE (ALL DATA)

Plate number	Number of measurements	Approximate flow (m^3/min)	10%	20%	30%	50%
5	702	0.7	68.8	72.8	96.4	99.3
7	817	0.9	78.2	94.4	97.6	99.4
10	993	1.1	84.1	96.6	98.7	99.7
13	961	1.2	86.5	97.4	99.2	99.7
18	953	1.3	88.7	97.9	99.2	99.6

TABLE 23. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (ALL DATA)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0485	pH	1	33	4.39	4.32	-1.66	5.68
		2	33	4.00	3.93	-1.78	4.61
		3	33	3.56	3.51	-1.32	3.64
	Conductivity	1	31	20.20	20.57	1.85	21.37
	(µS/cm)	2	31	53.10	52.63	-0.89	10.15
		3	31	134.30	131.35	-2.19	5.91
	Acidity	1	15	44.50	60.71	36.43	37.19
	(µequiv/L)	2	15	107.70	131.49	22.09	19.57
		3	15	293.00	375.39	28.12	46.10
1085	pH	1	31	4.29	4.25	-0.91	5.98
		2	31	3.92	3.89	-0.77	4.50
		3	31	3.19	3.21	0.56	3.09
	Conductivity	1	28	24.70	25.91	4.89	24.19
	(µS/cm)	2	28	61.60	62.08	0.78	22.22
		3	28	322.20	330.36	2.53	20.29
	Acidity	1	15	54.60	70.93	29.90	29.65
	(µequiv/L)	2	15	129.00	150.10	16.36	19.22
		3	15	677.10	668.14	1.32	29.50

TABLE 24. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (OUTLIERS REMOVED)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0485	pH	1	31	4.39	4.37	-0.36	2.33
		2	31	4.01	3.97	-0.80	2.29
		3	31	3.56	3.54	-0.51	1.61
	Conductivity (µS/cm)	1	30	20.20	19.83	-1.85	7.25
		2	30	53.10	52.01	-5.82	7.98
		3	31	134.30	131.35	-2.19	5.91
	Acidity (µequiv/L)	1	15	44.50	60.71	36.43	51.19
		2	15	107.70	131.49	22.09	19.57
		3	14	293.00	332.21	13.38	13.87
1085	pH	1	29	4.29	4.27	-0.54	1.62
		2	30	3.92	3.92	-0.05	2.07
		3	30	3.19	3.22	1.03	1.58
	Conductivity (µS/cm)	1	27	24.70	24.86	0.64	11.98
		2	27	61.60	59.54	-3.34	6.62
		3	27	322.20	318.13	-1.26	5.53
	Acidity (µequiv/L)	1	14	54.60	66.99	22.70	22.46
		2	15	129.00	150.10	16.36	19.22
		3	14	677.10	713.01	5.30	13.55

TABLE 25. ACID RAIN AUDIT RESULTS FOR ANIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0485	SO_4 (reported as S)	1	28	0.66	0.89	34.44	63.87
		2	29	2.37	2.83	19.24	50.60
		3	28	3.39	3.53	4.01	23.90
	NO_3 (reported as N)	1	29	0.11	0.12	8.18	19.33
		2	29	0.12	0.19	62.93	132.28
		3	29	1.80	1.80	0.00	9.01
	Cl	1	27	0.39	0.71	81.22	260.50
		2	28	0.38	0.70	86.97	259.60
		3	29	1.29	1.61	24.65	105.41
	F	1	18	0.05	0.05	-3.70	36.54
		2	19	0.09	0.09	-3.37	30.23
		3	20	0.18	0.17	-3.87	11.49
1085	SO_4 (reported as S)	1	29	0.84	1.05	24.76	53.56
		2	28	2.57	3.05	18.64	50.80
		3	30	5.70	5.92	3.90	20.76
	NO_3 (reported as N)	1	30	0.14	0.16	8.33	69.87
		2	30	0.12	0.13	10.26	68.99
		3	30	2.01	2.23	10.89	66.41
	Cl	1	27	0.29	0.33	15.03	52.58
		2	27	0.63	0.65	2.70	36.38
		3	29	8.33	8.08	-2.99	15.87
	F	1	13	0.04	0.04	-7.32	76.32
		2	13	0.09	0.09	2.27	34.44
		3	13	0.40	0.41	2.74	32.45

TABLE 26. ACID RAIN AUDIT RESULTS FOR ANIONS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0485	SO_4 (reported as S)	1	26	0.66	0.77	16.54	44.16
		2	27	2.37	2.50	5.18	28.14
		3	26	3.39	3.50	3.10	10.78
	NO_3 (reported as N)	1	28	0.11	0.12	5.45	15.52
		2	27	0.12	0.12	6.89	31.45
		3	28	1.80	1.77	-1.28	6.03
	Cl	1	26	0.39	0.36	-9.39	28.10
		2	27	0.38	0.36	-4.56	32.31
		3	28	1.29	1.31	1.40	40.29
	F	1	17	0.05	0.05	1.85	36.54
		2	18	0.09	0.09	2.25	17.58
		3	19	0.18	0.18	2.21	11.49
1085	SO_4 (reported as S)	1	27	0.84	0.92	8.87	28.07
		2	28	2.57	2.66	3.26	13.05
		3	28	5.70	5.63	-1.21	20.76
	NO_3 (reported as N)	1	29	0.14	0.14	-4.17	25.36
		2	29	0.12	0.11	-3.42	27.43
		3	29	2.01	1.97	-2.19	16.78
	Cl	1	25	0.29	0.29	1.05	35.29
		2	24	0.63	0.62	-1.59	12.76
		3	28	8.33	8.25	-1.06	15.87
	F	1	12	0.04	0.03	-21.95	50.00
		2	12	0.09	0.10	11.36	16.33
		3	11	0.40	0.41	1.49	7.35

TABLE 27. ACID RAIN RESULTS FOR CATIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0485	NH_3 (reported as N)	1	24	0.08	0.08	3.85	38.27
		2	25	0.61	0.60	-1.63	21.93
		3	25	0.89	0.93	3.46	5.83
	Ca	1	22	0.05	0.07	37.04	93.24
		2	22	0.06	0.07	28.07	79.45
		3	23	0.05	0.12	133.96	216.13
	K	1	25	0.09	0.09	1.16	25.29
		2	25	0.08	0.09	10.13	48.28
		3	25	0.08	0.08	4.00	40.24
	Mg	1	24	0.02	0.02	5.26	60.00
		2	24	0.01	0.05	420.00	353.85
		3	25	0.04	0.05	17.95	37.00
	Na	1	26	0.19	0.19	1.03	37.24
		2	26	0.25	0.23	-6.48	22.08
		3	26	0.40	0.38	-5.74	21.16
1085	NH_3 (reported as N)	1	24	0.08	0.10	30.00	72.11
		2	24	0.63	0.72	15.47	70.44
		3	24	0.66	0.86	31.35	64.66
	Ca	1	23	0.05	0.08	52.00	86.84
		2	24	0.14	0.14	2.86	43.75
		3	24	3.60	3.75	4.05	11.44
	K	1	22	0.07	0.09	16.22	50.00
		2	22	0.09	0.10	14.44	35.92
		3	23	5.43	4.94	-9.01	30.34
	Mg	1	24	0.02	0.02	15.00	52.17
		2	23	0.01	0.01	16.67	85.71
		3	24	0.35	0.53	5.11	134.96
	Na	1	23	0.18	0.19	9.09	30.21
		2	23	0.24	0.25	4.94	28.24
		3	23	0.50	0.54	7.54	19.37

TABLE 28. ACID RAIN AUDIT RESULTS FOR CATIONS (OUTLIERS REMOVED)

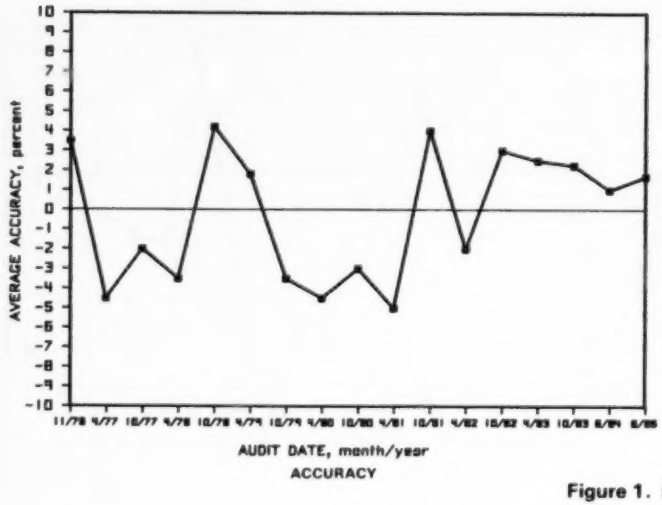
Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0485	NH_3 (reported as N)	1	22	0.08	0.08	2.56	23.75
		2	24	0.61	0.63	2.61	6.85
		3	24	0.89	0.91	2.68	4.90
	Ca	1	21	0.05	0.06	14.81	64.52
		2	20	0.06	0.06	0.00	36.84
		3	22	0.05	0.07	30.19	72.46
	K	1	23	0.09	0.08	4.65	15.85
		2	23	0.08	0.08	-2.53	24.68
		3	24	0.08	0.08	-3.75	29.87
	Mg	1	22	0.02	0.02	-10.53	29.41
		2	23	0.01	0.01	40.00	114.29
		3	24	0.04	0.04	10.26	30.23
	Na	1	24	0.19	0.19	-1.03	9.90
		2	25	0.24	0.24	-2.43	7.88
		3	25	0.40	0.39	-1.98	5.60
1085	NH_3 (reported as N)	1	23	0.08	0.09	13.75	42.86
		2	23	0.63	0.62	0.64	19.90
		3	23	0.66	0.76	15.22	28.14
	Ca	1	22	0.05	0.06	30.00	69.23
		2	23	0.14	0.13	5.00	29.32
		3	21	3.60	3.70	2.75	6.16
	K	1	21	0.07	0.08	6.76	36.71
		2	21	0.09	0.10	6.67	21.88
		3	22	5.43	5.14	-5.34	23.04
	Mg	1	23	0.02	0.02	5.00	38.10
		2	23	0.01	0.01	0.00	58.33
		3	23	0.35	0.39	9.94	21.71
	Na	1	22	0.18	0.18	3.41	18.68
		2	22	0.24	0.24	-0.82	14.11
		3	21	0.50	0.51	1.98	9.34

TABLE 29. ACID RAIN AUDIT RESULTS FOR TRACE METALS (ALL DATA)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0485	Mn	4	15	0.04	0.04	-2.27	12.95
		5	16	0.10	0.10	2.00	6.86
	Fe	4	15	0.05	0.06	5.56	19.30
		5	15	0.11	0.11	3.70	8.04
	Cd	4	14	0.01	0.02	6.67	37.50
		5	15	0.08	0.07	-6.58	19.72
	Cu	4	15	0.06	0.05	-5.17	21.82
		5	15	0.15	0.14	-1.36	5.52
	Ni	4	12	0.04	0.04	2.50	14.63
		5	12	0.08	0.08	2.50	13.10
	Pb	4	15	0.07	0.06	-7.58	22.95
		5	15	0.28	0.27	-3.93	9.29
	Zn	4	16	0.14	0.14	1.41	18.06
		5	16	0.61	0.61	0.33	8.20
1085	Mn	4	16	0.11	0.11	-2.63	18.02
		5	15	0.03	0.03	-6.25	13.33
	Fe	4	14	0.07	0.08	11.43	21.79
		5	14	0.03	0.03	11.11	43.33
	Cd	4	15	0.14	0.14	0.73	7.25
		5	15	0.02	0.02	13.64	20.00
	Cu	4	17	0.20	0.21	2.96	10.53
		5	16	0.06	0.06	1.79	14.04
	Ni	4	13	0.12	0.12	2.48	5.65
		5	13	0.06	0.05	-10.34	26.92
	Pb	4	16	0.44	0.40	-8.22	19.15
		5	16	0.14	0.11	-19.01	33.91
	Zn	4	15	0.82	0.84	1.70	5.01
		5	15	0.16	0.16	0.62	5.56

TABLE 30. ACID RAIN AUDIT RESULTS FOR TRACE METALS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0485	Mn	4	14	0.04	0.04	0.00	11.36
		5	15	0.10	0.10	1.00	4.95
	Fe	4	14	0.05	0.05	1.85	14.55
		5	14	0.11	0.11	4.63	7.07
	Cd	4	13	0.02	0.02	0.00	13.33
		5	14	0.08	0.07	-2.63	13.51
	Cu	4	14	0.06	0.06	0.00	12.07
		5	15	0.15	0.15	-1.36	5.52
	Ni	4	11	0.04	0.04	0.00	7.50
		5	11	0.08	0.08	5.00	10.98
	Pb	4	14	0.07	0.06	-3.03	12.50
		5	14	0.28	0.27	-1.79	4.73
	Zn	4	15	0.14	0.14	2.11	11.51
		5	15	0.61	0.60	2.12	3.84
1085	Mn	4	15	0.11	0.11	0.00	14.91
		5	14	0.03	0.03	-6.25	13.33
	Fe	4	14	0.07	0.08	11.43	21.79
		5	13	0.03	0.03	0.00	37.04
	Cd	4	15	0.14	0.14	0.73	7.25
		5	14	0.02	0.03	18.18	15.38
	Cu	4	16	0.20	0.20	0.49	6.37
		5	16	0.06	0.06	1.79	14.04
	Ni	4	13	0.12	0.12	2.48	5.65
		5	12	0.06	0.05	5.17	16.36
	Pb	4	15	0.44	0.42	-4.34	9.31
		5	15	0.14	0.12	-13.38	21.14
	Zn	4	14	0.82	0.83	0.85	5.01
		5	15	0.16	0.16	0.62	5.56



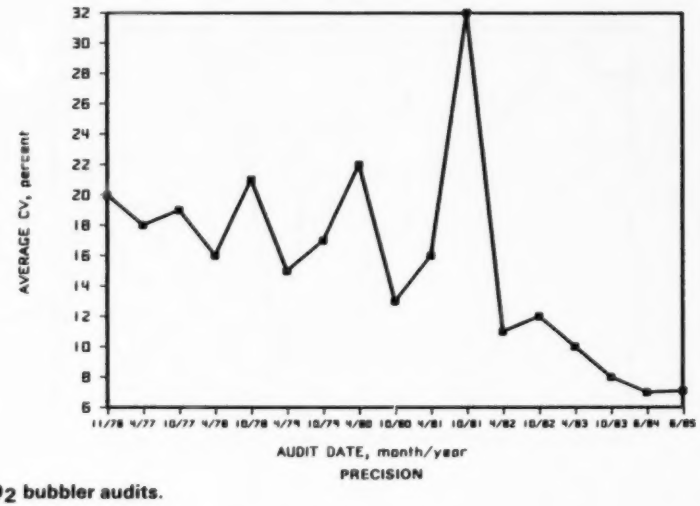
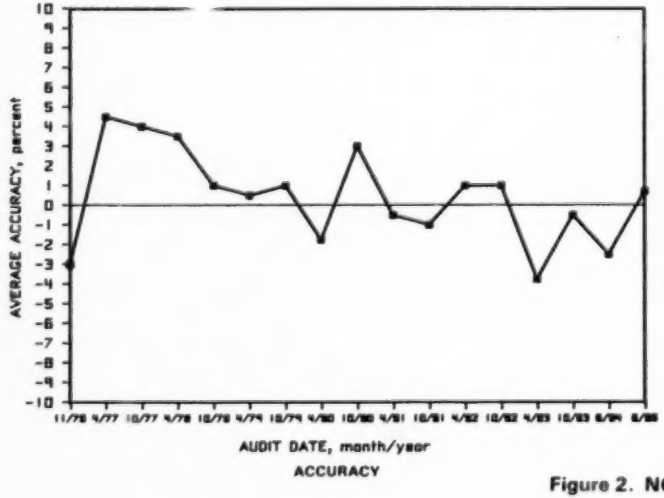


Figure 1. SO_2 bubbler audits.



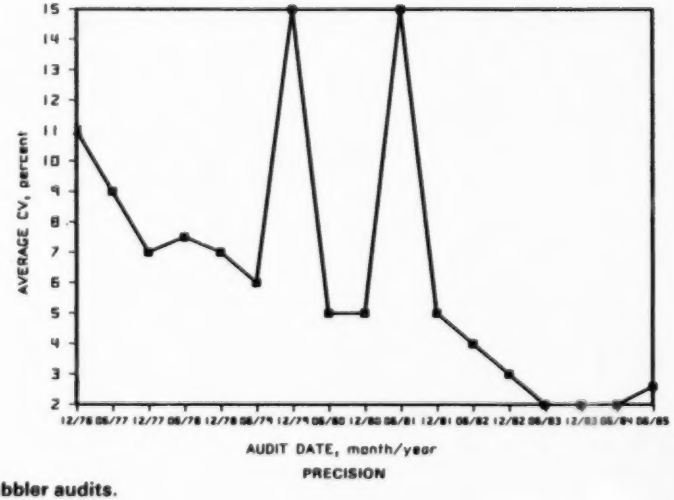
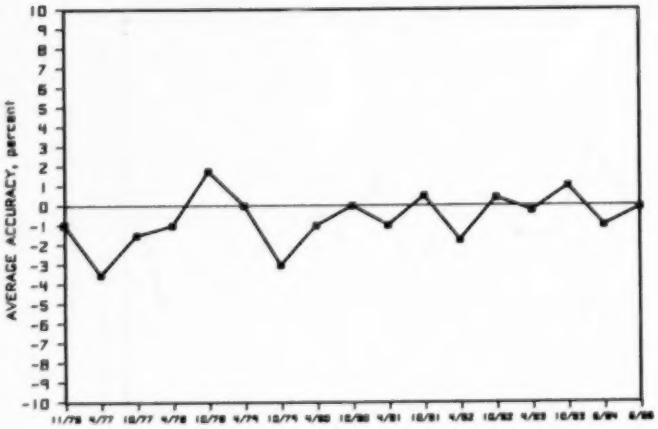


Figure 2. NO_2 bubbler audits.



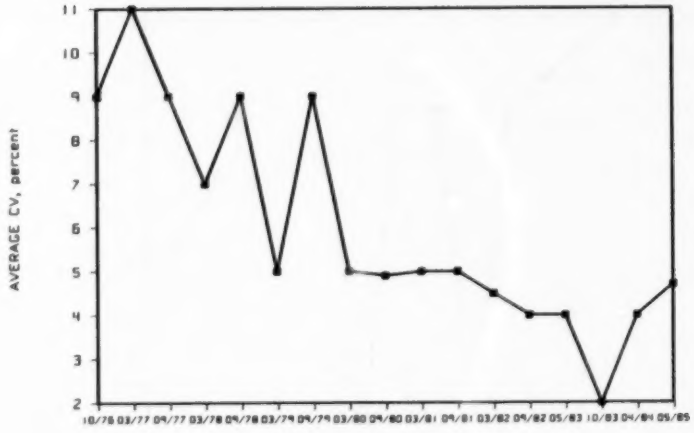
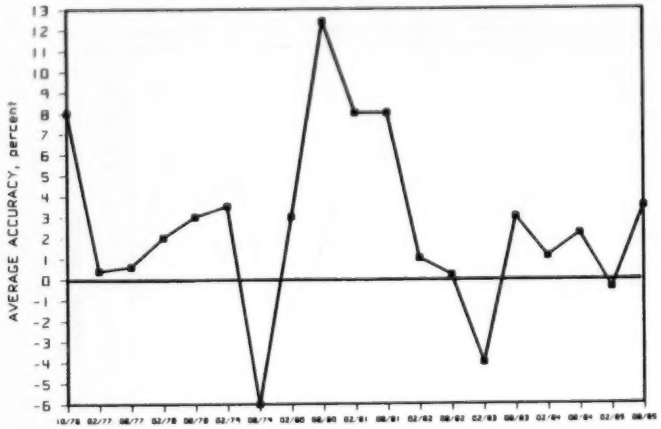


Figure 3. Carbon monoxide audits.



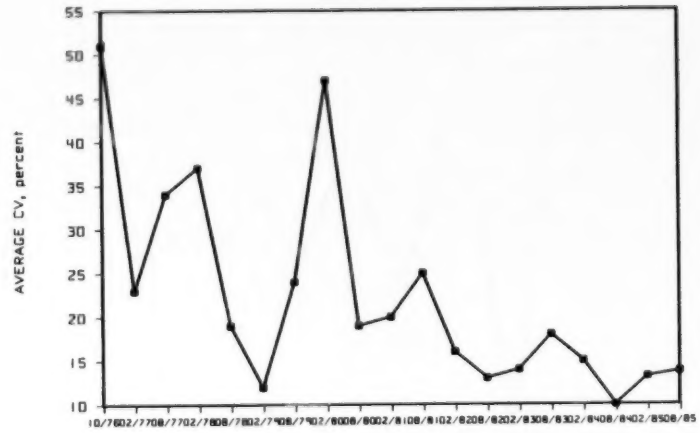


Figure 4. Sulfate audits

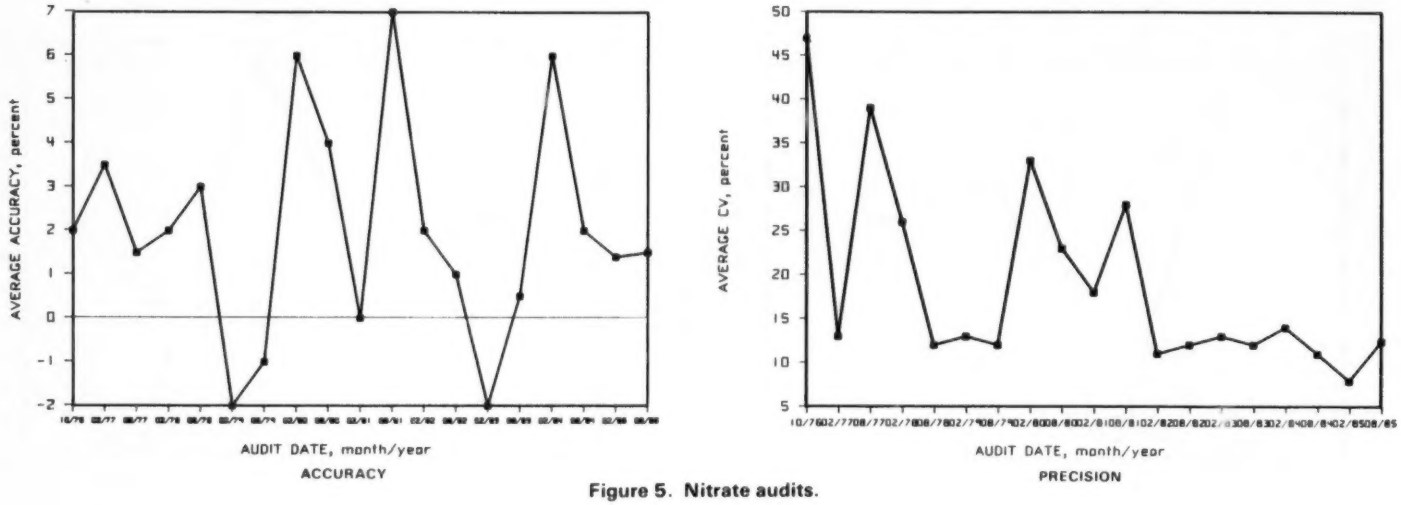


Figure 5. Nitrate audits.

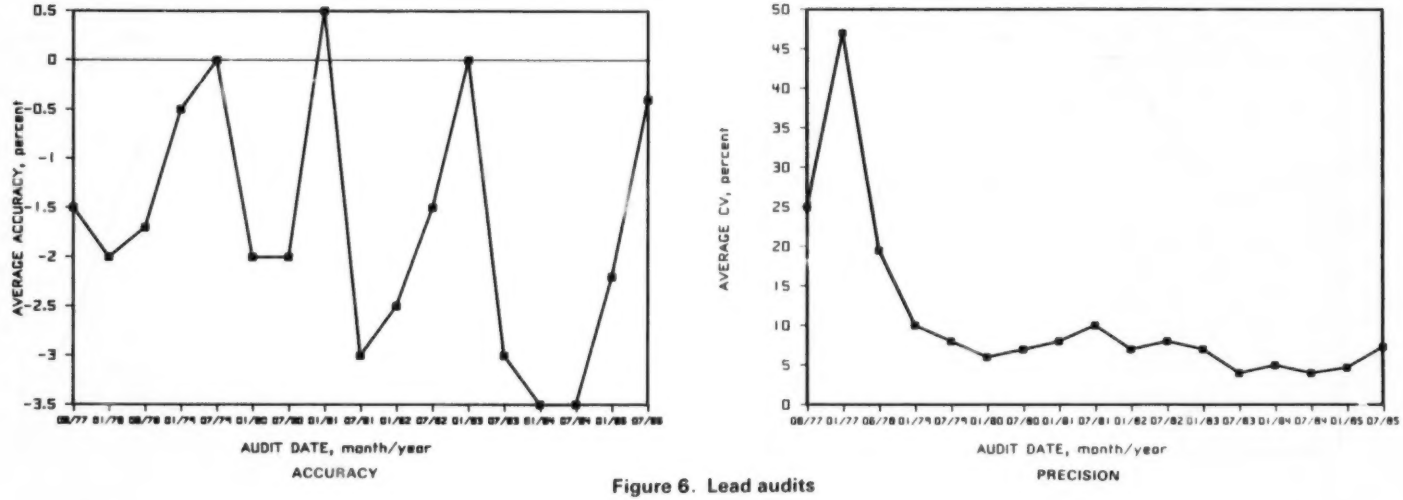


Figure 6. Lead audits

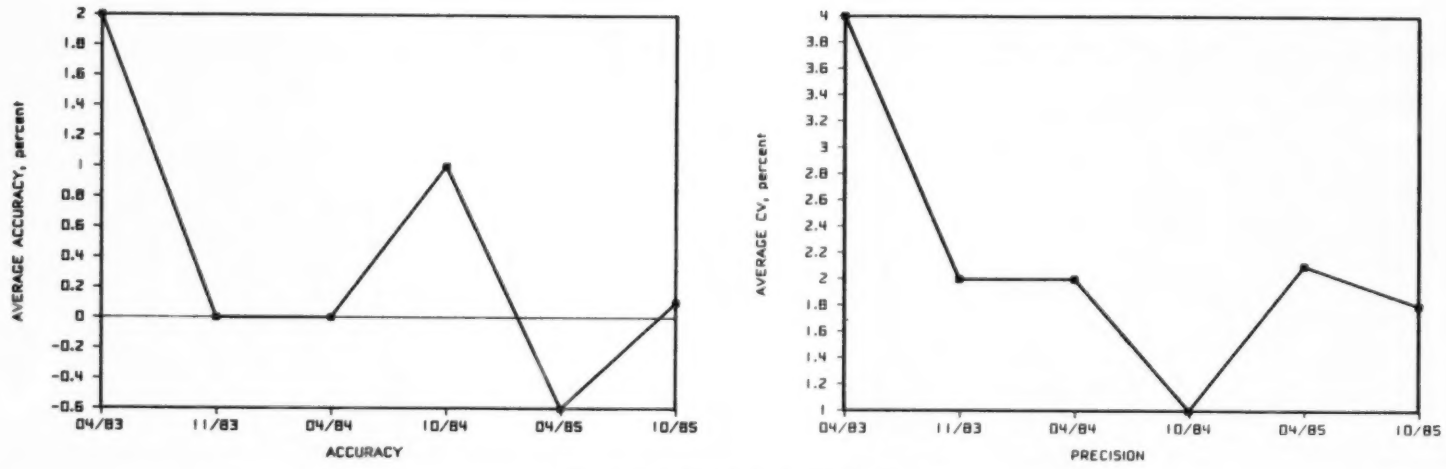


Figure 7. Acid rain audit results for pH.

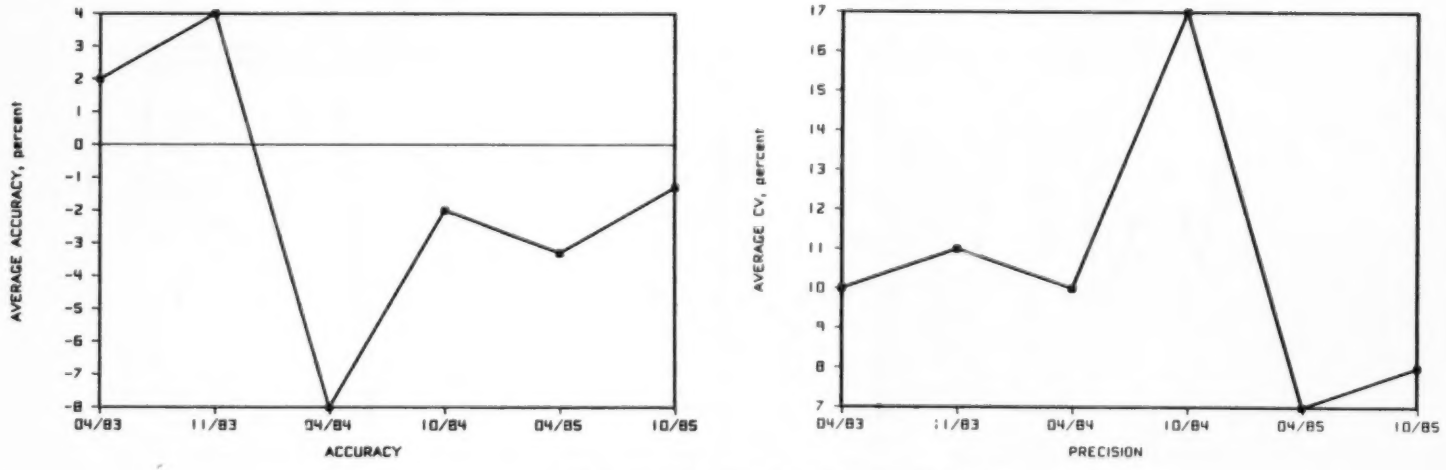


Figure 8. Acid rain audit results for conductivity.

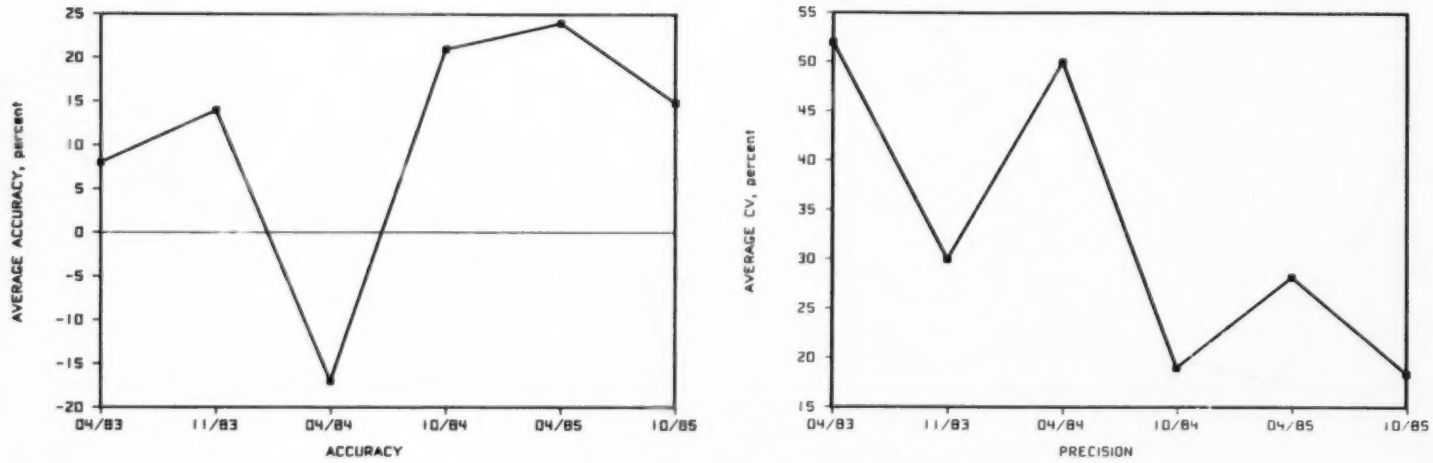


Figure 9. Acid rain audit results for acidity.

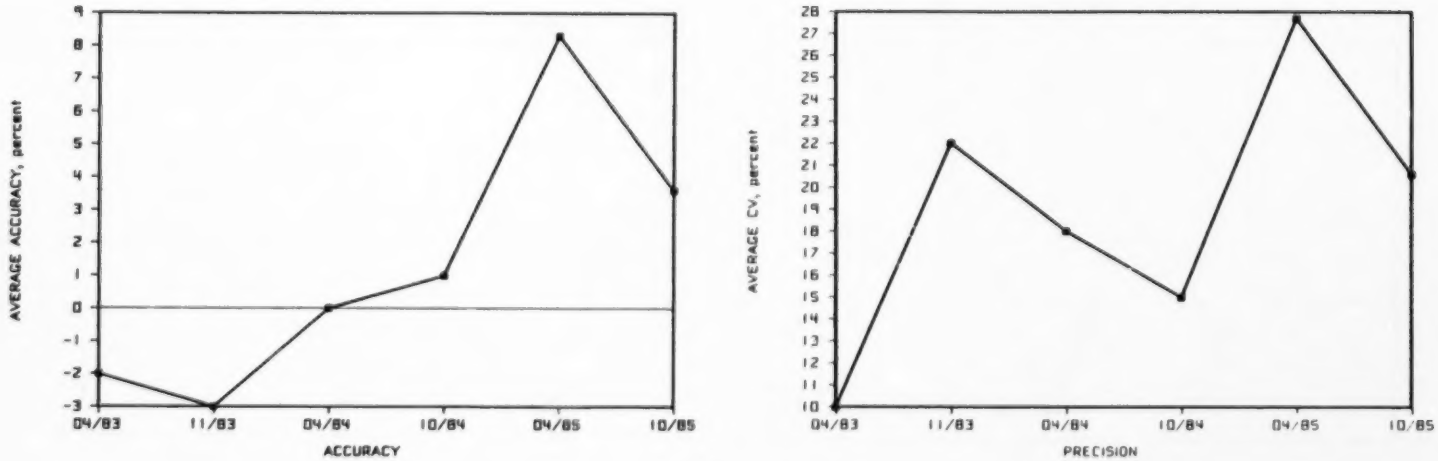


Figure 10. Acid rain audit results for SO_4 (reported as S).

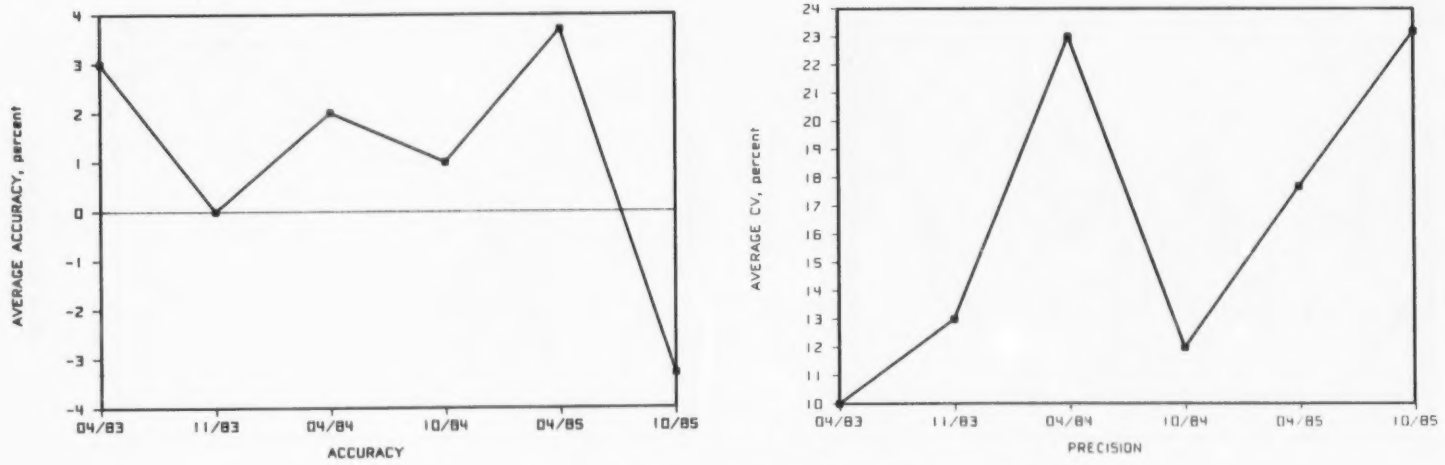


Figure 11. Acid rain audit results for NO_3 (reported as N).

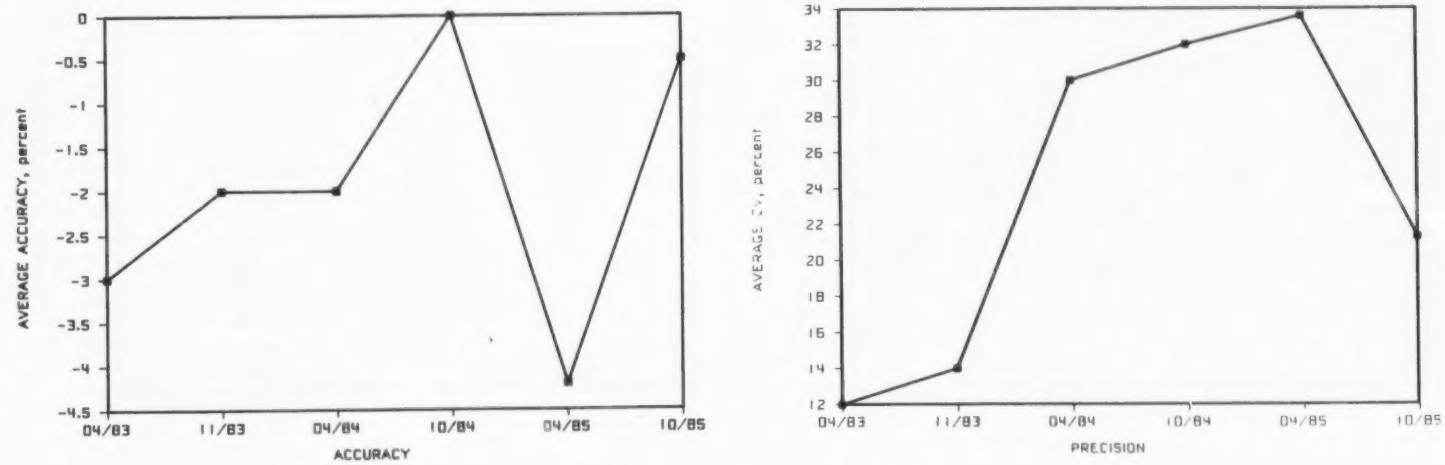


Figure 12. Acid rain audit results for Cl.

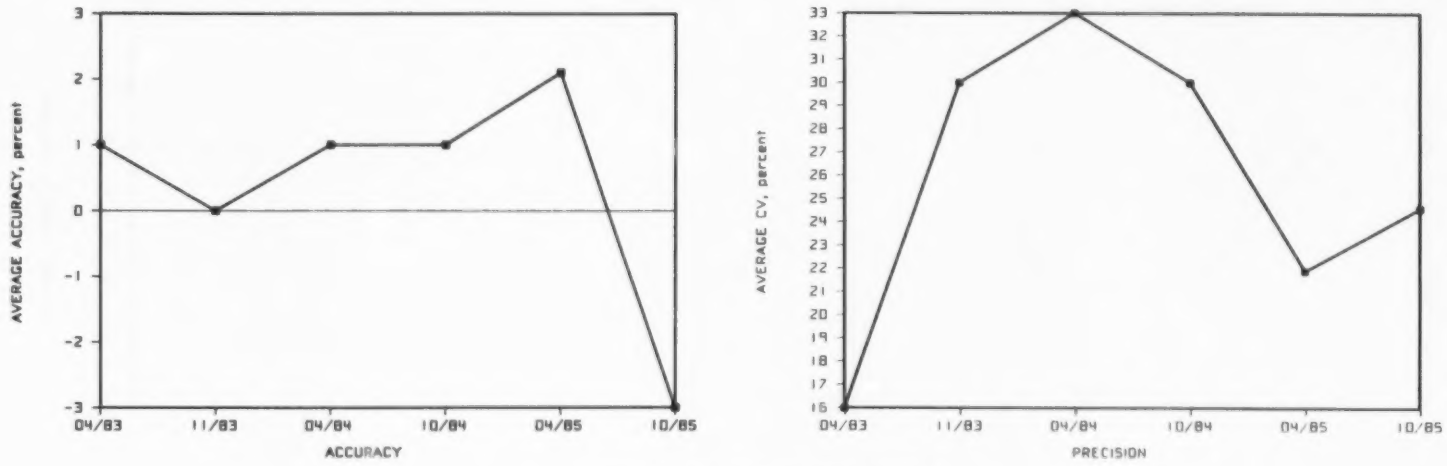


Figure 13. Acid rain audit results for F.

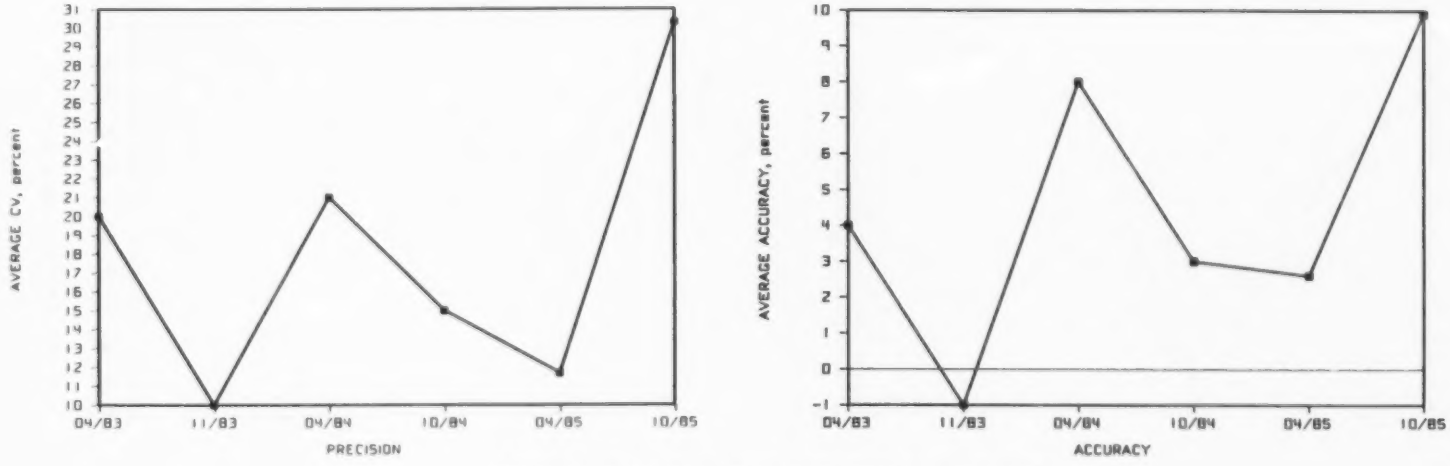


Figure 14. Acid rain audit results for NH_4 (reported as N).

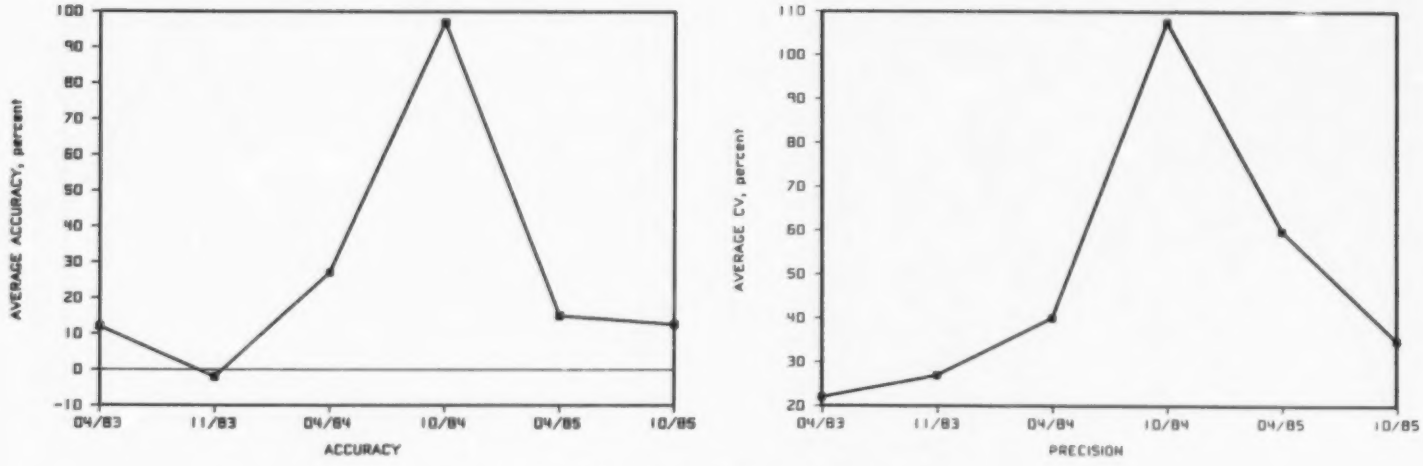


Figure 15. Acid rain audit results for Ca.

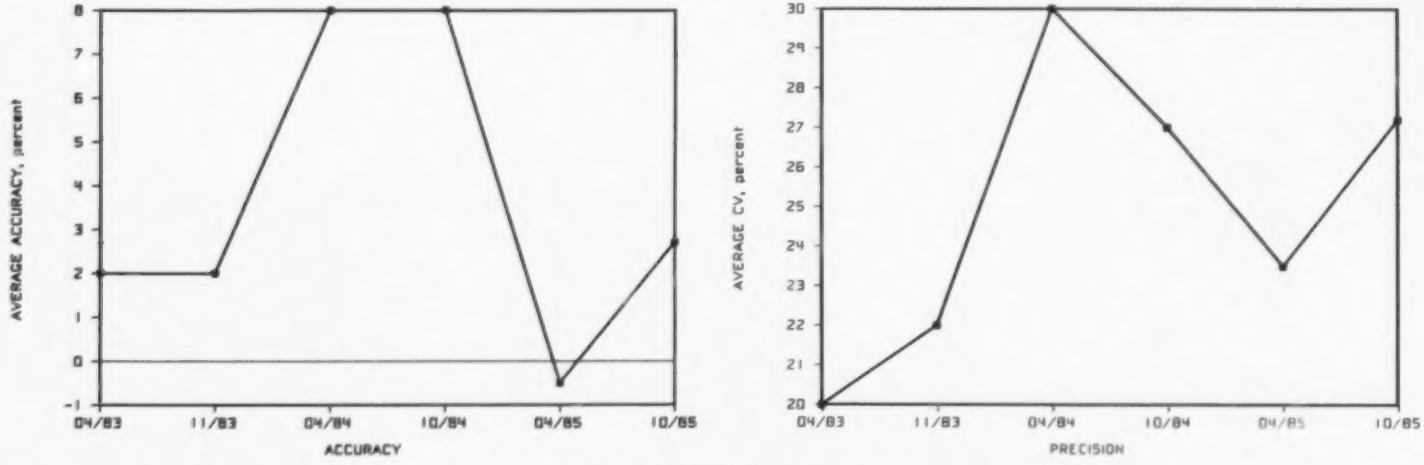


Figure 16. Acid rain audit results for K.

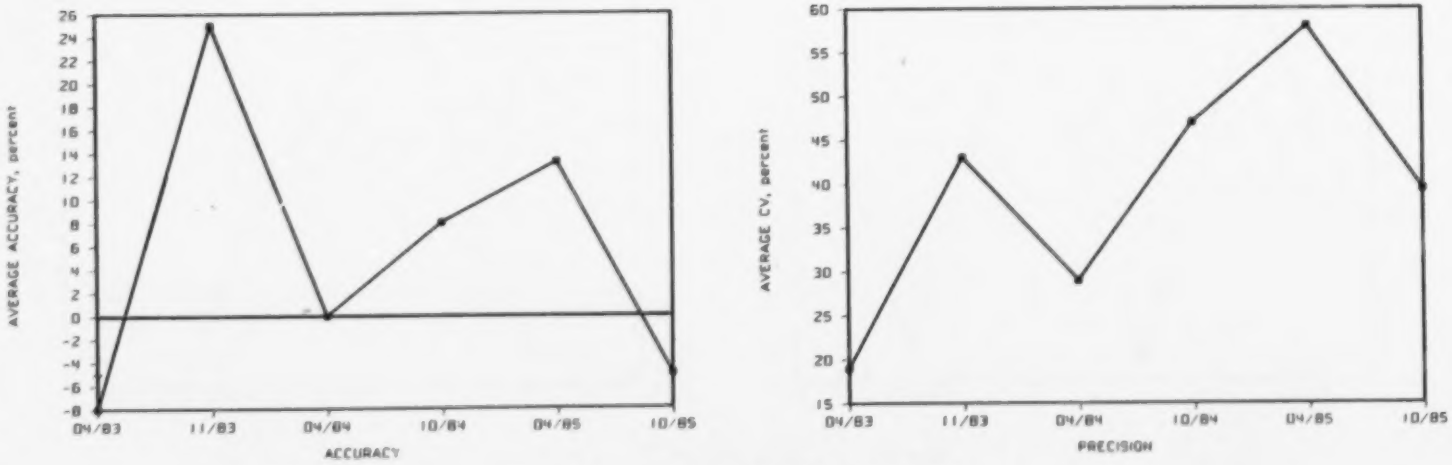


Figure 17. Acid rain audit results for Mg.

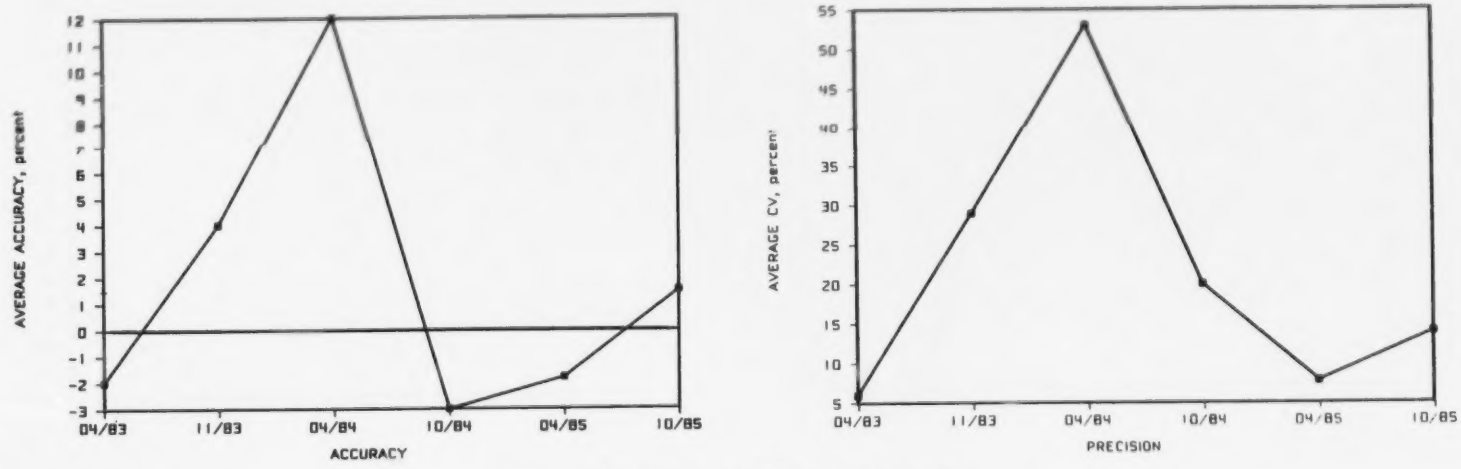


Figure 18. Acid rain audit results for Na.

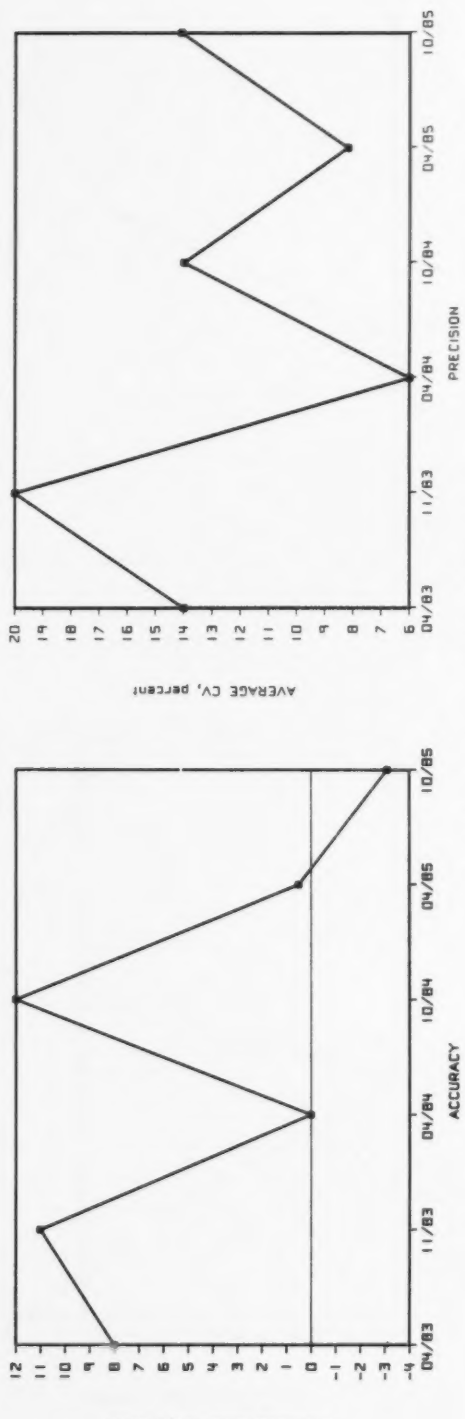


Figure 19. Acid rain audit results for Mn.

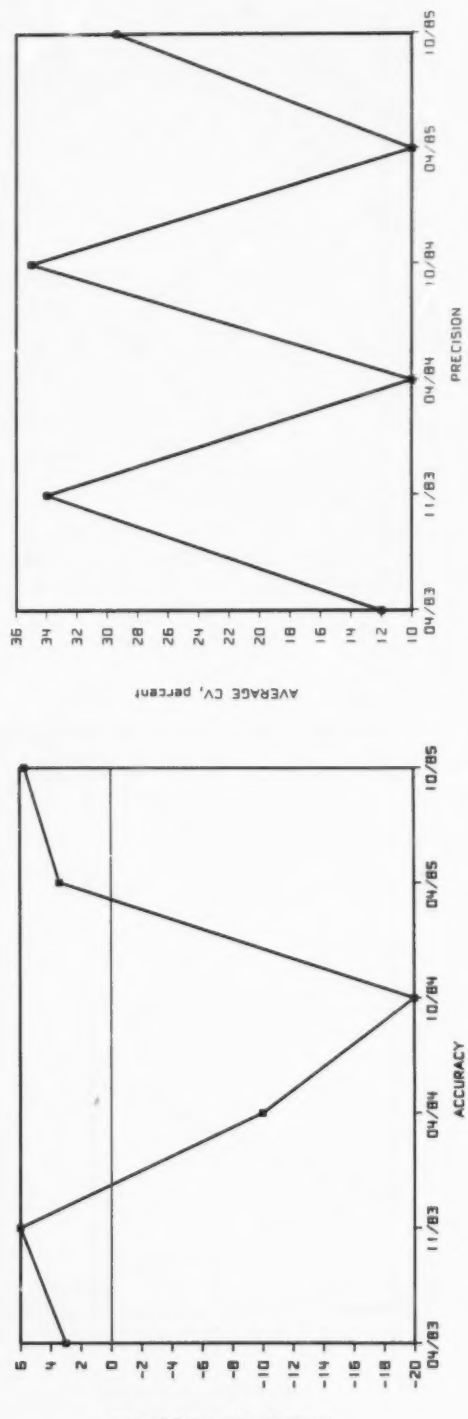


Figure 20. Acid rain audit results for Fe.

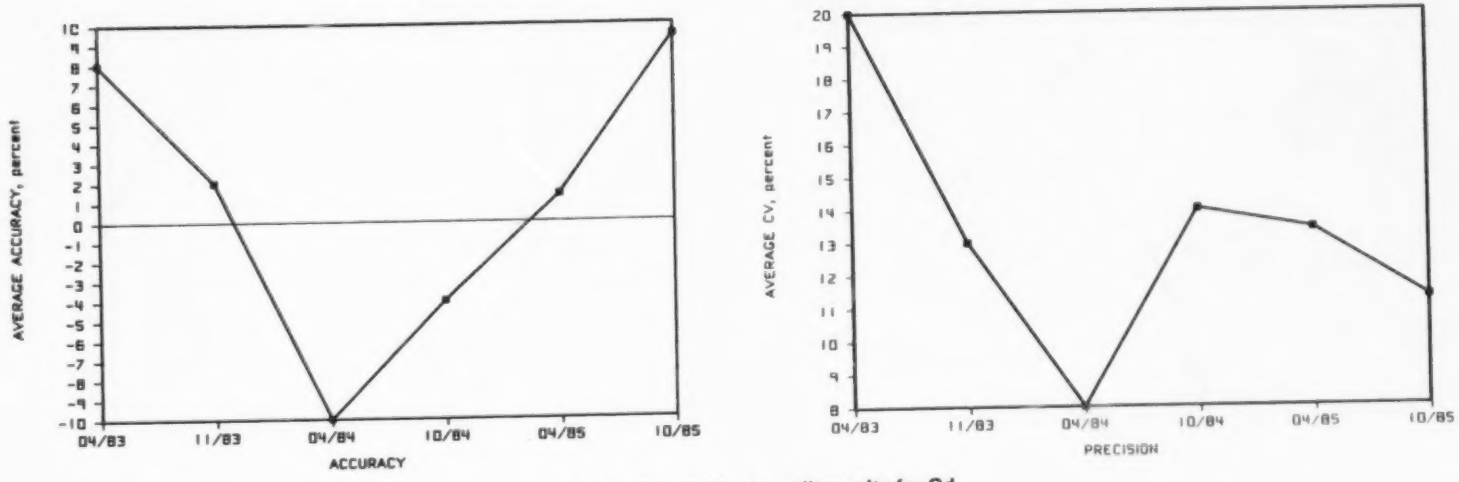


Figure 21. Acid rain audit results for Cd.

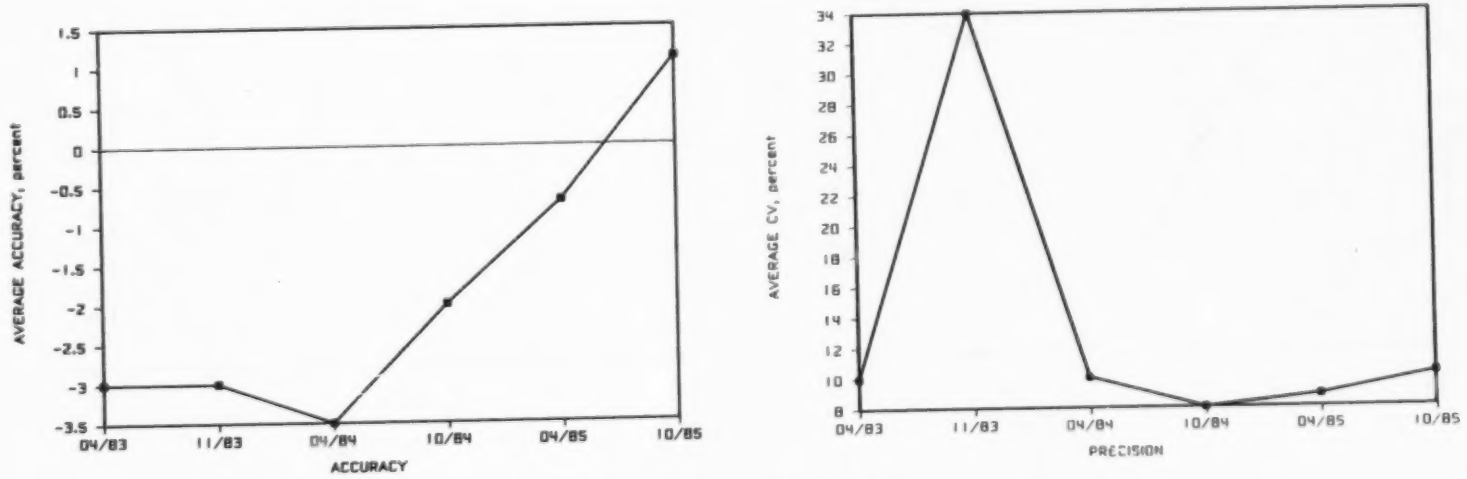


Figure 22. Acid rain audit results for Cu.

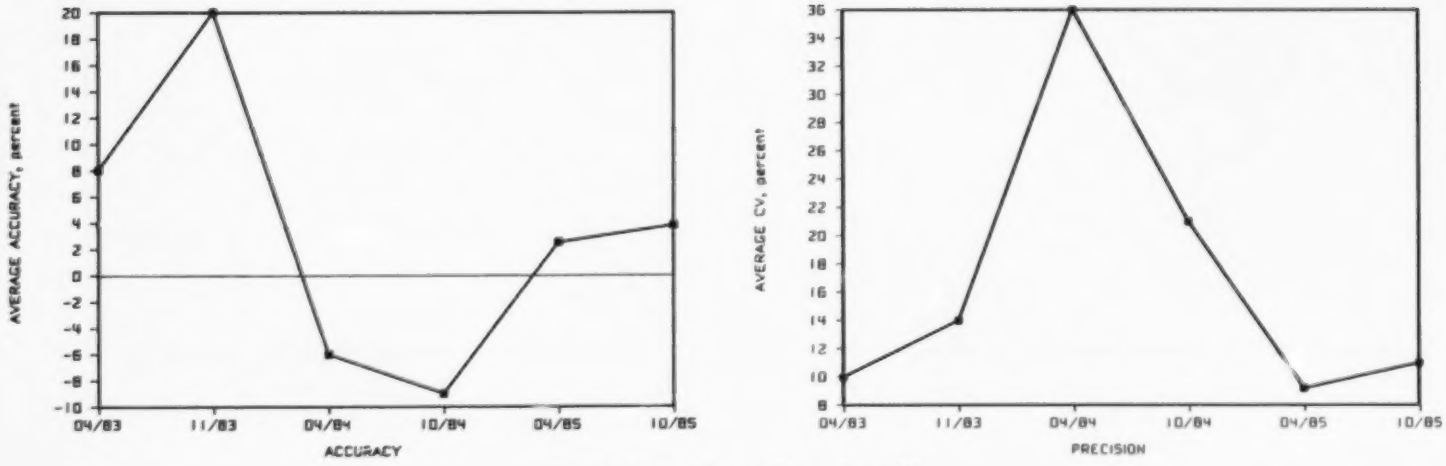


Figure 23. Acid rain audit results for Ni.

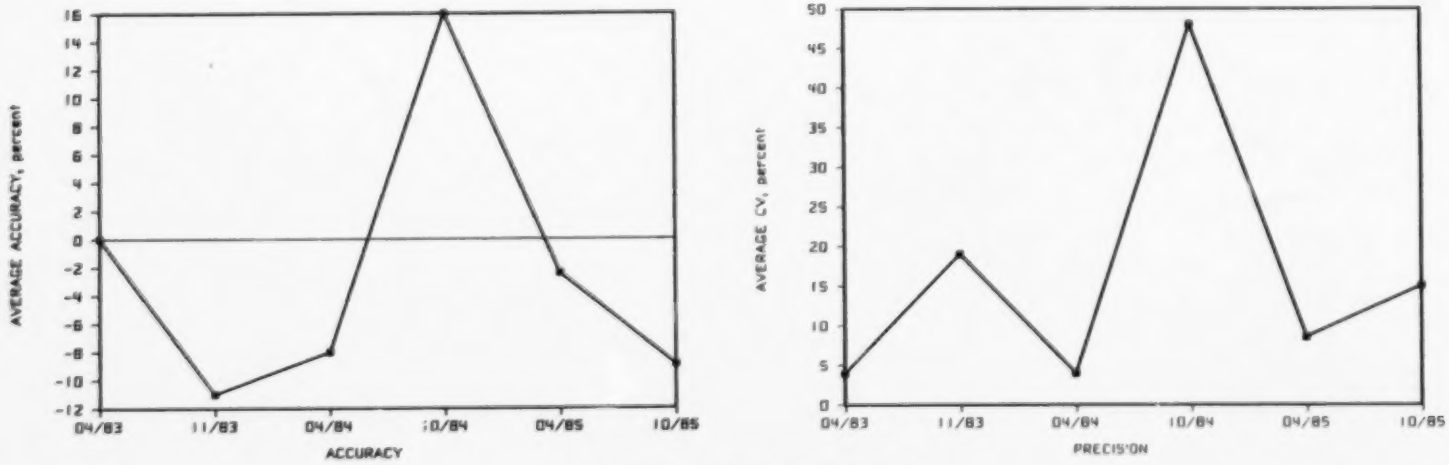


Figure 24. Acid rain audit results for Pb.

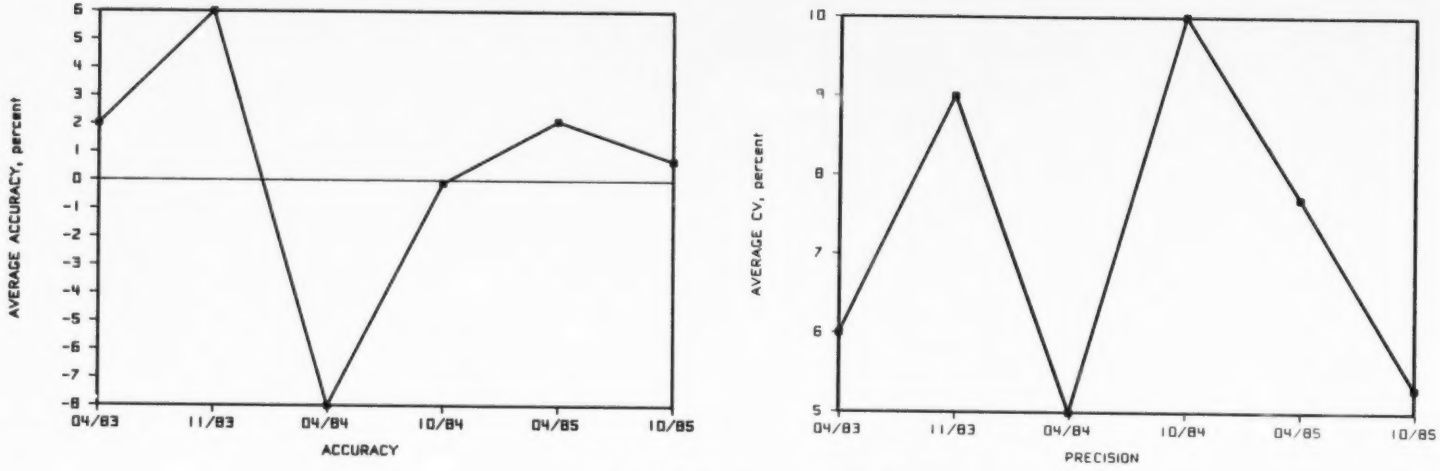


Figure 25. Acid rain audit results for Zn.

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